ECONOMIC ANALYSES OF NUTRIENT AND SEDIMENT REDUCTION ACTIONS TO RESTORE CHESAPEAKE BAY WATER QUALITY

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Executive Summary

In developing revised water quality criteria, designated uses, and boundaries for those uses to protect living resources in the Chesapeake Bay and its tidal waters, the Environment Protection Agency's (EPA) Chesapeake Bay Program Office provided to Bay jurisdictions information for development of water quality standards for dissolved oxygen, clarity, and chlorophyll *a* in its guidance document *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability* (*Technical Support Document*) (U.S. EPA Chesapeake Bay Program. 2003.). Part of the jurisdictions' water quality standards development process may be to conduct use attainability analyses (UAAs). The information contained in the *Technical Support Document* is to assist states in development of their individual UAAs, and serve as a basis for state-specific documents that will be initiated after the revised criteria for the Chesapeake Bay are finalized by EPA.

This document supplements the *Technical Support Document* by presenting economic analyses performed by the Chesapeake Bay Program related to controls to meet the revised criteria and uses. Part I of the *Economic Analyses* provides estimates of the total annual cost of achieving the three levels of controls based on the costs of best management practices (BMPs) to remove nitrogen and phosphorus loads to the Chesapeake Bay. This cost information includes total capital cost requirements, and to the extent that information could be compiled, estimates of how these costs may be shared between the public and private sectors. Part II describes economic modeling of the potential impacts of these control costs in the Bay region. Part III documents a screening-level analysis of potential impacts, also based on the costs of the tier scenarios. Although this information may be useful to states in developing their own UAAs, the Bay Program did not use these analyses to delineate boundaries for the new refined designated uses.

Summary of Estimated Costs

The Chesapeake Bay Program's estimated costs of the tier scenarios reflect the costs of BMPs to remove nitrogen and phosphorus; these BMPs also remove sediment to some extent and, therefore, capture a portion of sediment removal costs. Costs for publicly owned treatment works (POTWs) and industrial sources are based on facility-provided estimates; the Bay Program's Nutrient Reduction Technology (NRT) Task Force developed a methodology to estimate the costs of achieving the tier-specific effluent concentrations when facilities did not provide estimates.

Costs for urban, agriculture, forestry, and onsite system BMPs are based on the units (e.g., acres) of BMP implementation in each tier scenario, and BMP-specific estimates of capital and operation and maintenance (O&M) costs. The Chesapeake Bay Program performed an extensive literature search that included documents provided or prepared by Chesapeake Bay Program workgroups and stakeholders (e.g., tributary strategy reports), academic journals, studies by University Extension offices, the U.S. Department of Agriculture, the U.S. EPA, and others to estimate such costs. In addition, to estimate the costs for the onsite system denitrification BMP, the Chesapeake Bay Program collected data from manufacturers of onsite system denitrification technology. Of the available data on cost estimates, the Chesapeake Bay Program prioritized well-documented sources and studies in or near the Chesapeake Bay watershed. In general, the Chesapeake Bay Program used a simple average of the estimated costs from appropriate sources.

The costs to implement the tier scenarios include capital costs to install controls and annual O&M costs. Part I provides details of the methods and results of the cost analyses, including estimates of the total annual cost of achieving the tier scenarios, total capital cost requirements, and, to the extent that information is available, estimates of how costs may be shared between the public and private sectors. The total annual costs shown here include annualized capital costs for control technologies or BMPs that require initial capital expenditures and annual O&M expenditures, regardless of whether costs accrue to private-sector businesses and households or public entities that provide funding through cost-share programs. The estimates represent the annual costs at full implementation of the tier scenarios. Therefore, actual annual costs in the years prior to meeting the full implementation goals will likely be lower.

Total capital costs represent total initial expenditures for all source controls. Capital costs indicate overall financing requirements to achieve the level of control or degree of BMP implementation specified for each tier. The costs, however, will not be incurred in any single year. Instead, they will be spread over many years though gradual implementation.

The distinction between private and public cost estimates is based on cost-share assumptions developed using current cost-share information for the agricultural and POTW sectors to project the share of future costs accruing to the public sector. The cost share assumptions vary according to individual state programs. There are no cost-share assumptions for urban BMPs although retrofit BMPs for developed areas may receive financial support from federal and state sources. They may also benefit greatly from "piggy back" opportunities that reduce incremental BMP costs to a fraction of the unit costs because BMPs can be added more cost-effectively to planned infrastructure upgrades, repairs, or investments.

Exhibit ES-1 provides a summary of cumulative costs for each tier. These are costs beyond what has already been expended up to the year 2000 (and already funded POTW upgrades). It is important to note that some portion of Tier 2 and 3 costs will be incurred regardless of tier implementation because of baseline requirements that are not fully captured in the Tier 1 scenario (e.g., livestock BMPs required in a recent federal rule). Finally, the costs include those paid by businesses and households in the watershed as well as costs paid through federal and state cost-share programs.

Exhibit ES-1 also shows the implied average annual costs for each of the projected 6.3 million households by 2010, if all costs were paid by households living in the watershed (in reality, household costs will vary by location and household type, and a substantial share will be paid by federal and state sources). These annual costs are small compared to median household incomes in the watershed. The median estimate for the counties in the watershed is $49,300. This estimate is in 2001 dollars and reflects incomes in the 2000 Census of Population. Average median incomes across the states range from $37,800 for the basin counties in New York to $58,300 for the basin counties in Maryland.

Exhibit ES-1: Summary of Total Annual Cumulative Costs (in 2001 dollars)

Cost Category	Tier 1 (cost of current programs funded to 2010)[1]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1+ Tier 2 + Tier 3)
Total Annual Costs ($millions)[2]	$198	$555	$1,139
Implied Cost per Household Before Cost Share[3] ($)	$31	$88	$181
Implied Cost per Household After Cost Share[3] ($)	$24	$59	$130
Implied Household Cost Before Cost Share as Percent of MHI in Watershed ($49,300)	0.1%	0.2%	0.4%
Implied Household Cost After Cost Share as Percent of MHI in Watershed ($49,300)	0.0%	0.1%	0.3%
Federal and State Funding Share (%)	25%	33%	28%

MHI = median household income

1. POTW NRT upgrades already funded or completed are not included in Tier 1.
2. Includes costs paid by federal and state cost-share programs.
3. Actual household costs will vary by location and type of household (e.g., urban or farm) and will be reduced by the federal and state funding shares. The impact analysis addresses these distributional effects.

Federal and state cost-share programs provide financial support for nutrient controls. Based on current practices, these programs could provide up to $49 million of annual Tier 1 costs (or 25%), $186 million of annual Tier 2 costs (or 33%), and $317 million of annual Tier 3 costs (or 28%). The total cost-share contribution increases from Tier 1 to Tier 2 because agricultural costs increase relative to other sectors, and most agricultural BMPs are covered by cost-share programs. The total cost-share contribution declines from Tier 2 to Tier 3 as urban costs, for which federal and state funding is possible but not included, increasingly dominate total costs. Average cost per household will also decrease if actual implementation of controls is more cost effective than the tier scenarios.

A breakdown of costs by state in **Exhibit ES-2** show that three states—Maryland, Pennsylvania, and Virginia—account for almost 90% of costs across all three tier scenarios. Maryland has the largest share of annual Tier 1 costs, followed by Virginia and Pennsylvania. However, Virginia has the highest share of Tier 2 and Tier 3 costs, followed by Pennsylvania and Maryland. Maryland's shift from highest baseline costs to third highest Tier 2 and Tier 3 costs illustrates its aggressive level of implementation already employed or planned.

Exhibit ES-2: Summary of Total Annual Cumulative Costs by Jurisdiction[1]
(millions of 2001 dollars)

Jurisdiction	Tier 1 (cost of current programs funded to 2010)[2]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)
Delaware	$3	$8	$13
District of Columbia	$9	$16	$34
Maryland	$63	$121	$262
New York	$7	$31	$66
Pennsylvania	$51	$167	$320
Virginia	$57	$192	$407
West Virginia	$7	$19	$37
Total	$198	$555	$1,139

Detail may not add to total due to rounding.
1. Includes costs paid by federal and state cost-share programs.
2. POTW NRT upgrades already funded or completed are not included.

The cumulative cost estimates shown in Exhibits ES-1 and ES-2 do not reflect the incremental costs of implementing controls beyond Tier 1 levels (or baseline levels that are essentially what would happen anyway). The incremental costs for Tiers 2 and 3 can be derived by subtracting the Tier 1 costs from the cumulative Tier 2 and 3 costs, respectively.

Corresponding total capital costs are $1.4 billion for Tier 1, $3.6 billion for Tier 2, and $8.0 billion for Tier 3. These estimates include anticipated federal and state cost shares. These costs will be incurred slowly over time as controls are gradually implemented. Nevertheless, comparing them to annual economic statistics provides crucial perspective because—despite their magnitude—they are small compared to total annual personal income, which in 1999 was $574 billion in the watershed counties and $1.4 trillion in the basin states (BEA, 2001; in 2001 dollars the values become $610 billion and $1.5 trillion, respectively).

State-level capital costs shown in **Exhibit ES-3** also include the portion that will be funded through federal and state cost-share programs as well as costs that will be paid by households in the watershed. The distribution of capital costs follows the same pattern as annual costs in Exhibit ES-2. Maryland, Pennsylvania, and Virginia account for approximately 90% of watershed costs across all tier scenarios. Maryland costs are highest in Tier 1, followed by Virginia and Pennsylvania. Tier 2 and Tier 3 capital costs in Virginia are highest, followed by Pennsylvania and Maryland.

Exhibit ES-3: Summary of Total Cumulative Capital Costs

Jurisdiction	Total Capital Cost (millions of 2001 dollars)[1]			Annual Total Personal Income in Watershed for 1999 (millions of 2001 dollars)[3]
	Tier 1 (cost of current programs funded to 2010)[2]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)	
Delaware	$21	$36	$60	$24,600
District of Columbia	$133	$170	$368	$21,600
Maryland	$592	$860	$2,069	$178,800
New York	$20	$175	$405	$47,400
Pennsylvania	$258	$899	$1,940	$134,700
Virginia	$382	$1,387	$2,901	$197,400
West Virginia	$35	$116	$232	$5,600
Total	$1,442	$3,644	$7,975	$610,000

Detail may not add to totals because of rounding.

1. Includes capital costs paid by federal and state cost-share programs.
2. POTW NRT upgrades already funded or completed are not included in Tier 1.
3. Total personal income in 1999 (BEA, 2001) in the counties located partially or wholly in the watershed. Values have been inflated to 2001 dollars using the Consumer Price Index.

For comparison purposes, Exhibit ES-3 also provides the 1999 estimates of total annual personal income for the watershed counties. In each jurisdiction, total capital costs for Tier 1 equal less than 0.7% of regional income. Thus, even if all capital costs were paid in a single year, instead of being spread over 10 to 20 years through gradual implementation and financing, they would be small compared to local economic activity. Total capital costs for Tier 2 equal less than 1% of regional income in each jurisdiction except West Virginia, where costs are 2.1% of income. Tier 3 capital costs equal less than 1% of income for Delaware and New York, less than 1.5% of income in Maryland, Pennsylvania and Virginia, less than 2% in the District of Columbia, and less than 5% in West Virginia.

These costs do not include the costs of onsite waste management systems (OSWMS; e.g., septic systems) in new homes. The rationale is that the additional expense associated with denitrification will be absorbed in the cost of a new home and the impact would, therefore, be limited to tradeoffs in what a homeowner can buy for the same price (e.g., changes in other materials or features in the home).

COSTS BY SECTOR

Exhibit ES-4 shows the breakdown of total annual costs and total capital costs by sector. In both instances, costs include those paid by the affected sectors and those that will be paid for by federal and state cost-share programs. State-level breakdowns are shown in the sector-specific sections below.

Exhibit ES-4: Total Annual and Capital Costs by Sector[1] (millions of 2001 dollars)

	Total Annual Cumulative Cost			Total Capital Cumulative Cost		
Sector	Tier 1 (cost of current programs funded to 2010)[2]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)	Tier 1 (cost of current programs funded to 2010)[2]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)
POTW	$53	$148	$286	$655	$1,615	$3,087
Industrial Sources	$0	$8	$15	$0	$51	$98
Agriculture	$61	$226	$376	$312	$850	$1,490
Forestry	$23	$27	$31	$0	$0	$0
Urban	$60	$146	$418	$475	$1,128	$3,233
OSWMS	$0	$0	$13	$0	$0	$68
Total	$198	$555	$1,139	$1,442	$3,644	$7,975

Detail may not add to total because of rounding.
1. Includes costs paid by federal and state cost-share programs.
2. POTW NRT upgrades already funded or completed are not included in Tier 1.

With respect to annual costs, the agriculture sector accounts for the highest share of Tier 1 costs, followed by urban and POTW costs. In Tier 2, agricultural costs dominate total costs (41%) followed by POTW costs (27%), but the urban sector has the highest cost share in Tier 3 (37%) followed by agricultural costs (33%).

The distribution of capital costs across sectors differs significantly also. POTW costs account for the largest share of capital costs in Tier 1 (45%) and Tier 2 (44%), followed by urban and agricultural costs. In Tier 3, urban costs account for the largest share (41%) followed by POTW and agricultural costs. Urban costs in Tier 3 go up significantly due to the amount of storm water retrofits, which increase from 5% in Tier 2 to 20% in Tier 3.

POTW and Industrial Source Costs

Costs for NRT among POTW and industrial sources include capital expenditures and annual O&M costs. There are no industrial control costs in Tier 1 because industrial Tier 1 actions are assumed to be those already in place or planned. In Tiers 2 and 3, POTW control costs account for more than 90% of annual NRT costs. Total annual costs of $156 million for Tier 2 include $148 million for POTWs and $8 million for industrial facilities. Similarly, annual Tier 3 costs of $301 million include $286 million for POTWs and $15 million for industrial facilities.

Costs for POTW controls in Tier 1 reflect NRT projects planned for 2010 that are not yet funded. This includes NRT planned for 154 out of the 304 significant POTWs in the Bay watershed; effluent concentrations for these facilities in 2010 should be 8 mg/l total nitrogen (TN). (Chesapeake Bay Program, 2002). Tier 1 POTW costs include costs for D.C. combined sewer overflows (CSOs) (capital cost of $130 million).

Tier 2 reflects costs to implement NRT in the remaining 150 POTWs and assumes, in general, TN and total phosphorus (TP) effluent concentrations of 8 mg/l and 1 mg/l, respectively. The technologies to achieve this level of reduction include extended aeration trains and denitrification zones for nitrogen removal and chemical addition systems for phosphorus removal systems. Tier 3 reflects costs of technologies necessary to implement NRT in all of the POTWs to effluent concentrations of 5 mg/l TN and 0.5 mg/l TP. The technologies to achieve this level of reduction include the addition of a secondary anoxic zone plus methanol addition, and additional clarification tankage for nitrogen removal and additional chemicals for phosphorus removal. (Note that limits of technology for point sources for nutrient removal are considered to be 3 and 0.1 mg/l TN and TP, respectively.) The technologies to achieve this level of reduction include deep bed denitrification for nitrogen removal and microfiltration for phosphorus removal.

Exhibit ES-5 shows annual POTW costs by tier scenario and jurisdiction. Similar to annual costs for all sectors, these results show that the largest share of Tier 1 costs occur in Maryland and the largest share of Tier 2 and Tier 3 costs occur in Virginia. These results show how planned (Tier 1) NRT implementation costs vary across these states. Maryland is planning expenditures of $29.5 million annually under Tier 1, which accounts for 81% of cumulative costs under Tier 2 and 35% of cumulative costs under Tier 3. In contrast, Pennsylvania's Tier 1 costs are $6.5 million, which accounts for 20% of cumulative Tier 2 costs and 11% of cumulative Tier 3 costs. Virginia's Tier 1 costs are $8.7 million, which equals 15% of cumulative Tier 2 costs and 9% of Tier 3 costs.

Total capital costs for POTWs and industrial dischargers are $0.7 billion for Tier 1, $1.7 billion for Tier 2, and $3.2 billion for Tier 3. This includes costs paid by households in the watershed as well as costs paid by federal and state cost-share programs. Similar to annual costs, POTWs accounts for more than 90% of these costs in each tier. The distribution of capital costs across states also mimics the distribution of annual costs shown in Exhibit ES-5.

Exhibit ES-6 provides a summary of total annual costs, including those paid by farmers and those paid by cost-share programs. Based on current implementation shares, the cost-share programs would account for approximately 75% of annual costs in Tiers 2 and 3; farmers would incur the remaining 25% of annual costs. Cost-share programs account for a smaller share of annual Tier 1 costs (60%) because BMPs with lower cost-shares such as animal waste management systems account for a larger portion of annual costs.

Exhibit ES-5: Summary of Total Annual Cumulative POTW Costs[1] (millions of 2001 dollars)

Jurisdiction	Tier 1 (cost of current programs funded to 2010)[2]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)
Delaware	$0.2	$0.6	$0.8
District of Columbia	$8.3	$14.1	$25.7
Maryland	$29.5	$36.2	$85.2
New York	$0.0	$6.2	$10.2
Pennsylvania	$6.5	$31.8	$60.0
Virginia	$8.7	$57.9	$101.3
West Virginia	$0.0	$1.7	$2.4
Total	$53.1	$148.3	$285.5

Detail may not add to total because of independent rounding.

1. Includes federal and state cost shares equal to 10% of capital costs for VA, 50% of capital costs for MD, and 0% for remaining jurisdictions.
2. POTW NRT upgrades already funded or completed are not included.

Exhibit ES-6: Summary of Total Annual Cumulative Agricultural Costs[1] (millions of 2001 dollars)

Jurisdiction	Tier 1 (cost of current programs funded to 2010)	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)
Delaware	$2.2	$6.3	$9.4
District of Columbia	$0.0	$0.0	$0.0
Maryland	$8.3	$33.8	$49.6
New York	$1.8	$14.7	$28.3
Pennsylvania	$22.2	$90.9	$146.6
Virginia	$21.6	$67.9	$118.3
West Virginia	$5.1	$12.7	$24.2
Total	$61.2	$226.3	$376.3

Detail may not add to total because of independent rounding.

1. Based on current cost share program information, federal and state cost-share programs would account for approximately 60% of annual costs in Tier 1 and 75% of costs in Tiers 2 and 3; farmers incur the remaining costs.

Agriculture Costs

Annual costs are highest in Pennsylvania for all tier scenarios. Virginia has the second highest share of costs in all scenarios, followed by Maryland. Together, Pennsylvania and Virginia account for 70% of annual agricultural costs.

Total capital costs in the agricultural sector are $312 million for Tier 1, $850 million for Tier 2, and $1.5 billion for Tier 3. The distribution of capital costs across states is similar to the annual cost distribution shown in Exhibit ES-6.

Forestry Costs

Annual costs to implement forest harvesting BMPs range from $23.5 million in Tier 1 to $30.8 million in Tier 3. Thus, baseline implementation in Tier 1 accounts for most of the costs in this sector. **Exhibit ES-7** provides annual cost estimates by tier scenario. This sector has the smallest share of annual costs in all tier scenarios because implementation acre estimates are small. All costs are annual because practices are assumed to be implemented on different harvest acres each year.

Exhibit ES-7: Summary of Annual Forest Harvest Costs by Tier and Jurisdiction (millions of 2001 dollars)

Jurisdiction	Tier 1 (cost of current programs funded to 2010)	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)
Delaware	<$0.1	<$0.1	$0.1
District of Columbia	$0.0	$0.0	$0.0
Maryland	$1.6	$1.8	$2.0
New York	$3.6	$4.1	$4.5
Pennsylvania	$13.9	$15.6	$17.4
Virginia	$3.0	$4.1	$5.1
West Virginia	$1.3	$1.5	$1.7
Total	$23.5	$27.1	$30.8

Note: Detail may not equal total due to rounding.

Urban Costs

Exhibit ES-8 provides annual costs by tier and jurisdiction for urban areas. These costs are for storm water BMPs and exclude POTW costs. Tier 1 costs are highest in Maryland and Virginia, with each accounting for 40% of annual Tier 1 costs. Maryland's share of costs declines in Tier 2 (32%) and Tier 3 (29%) while shares for other states, except Delaware, increase across the scenarios. This is indicative of Maryland's higher baseline BMP implementation rate compared to most other states. Virginia's share of total annual costs is 41% for Tiers 2 and 3. Pennsylvania's share of total annual costs increases from 15% in Tier 1 to 21% in Tier 3.

Exhibit ES-8: Summary of Cumulative Annual Urban Costs by Tier and Jurisdiction (millions of 2001 dollars)

Jurisdiction	Tier 1 (cost of current programs funded to 2010)	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1 + Tier 2 + Tier 3)
Delaware	$0.5	$1.0	$2.4
District of Columbia	$0.3	$2.1	$8.3
Maryland	$23.8	$47.3	$119.5
New York	$1.7	$6.4	$21.6
Pennsylvania	$8.8	$27.0	$87.7
Virginia	$24.1	$59.3	$170.5
West Virginia	$0.9	$2.5	$7.5
Total	$60.2	$145.5	$417.6

Note: Detail may not add to total due to rounding.

Storm water retrofits account for over 90% of annual urban costs in all tier scenarios. Although the total number of retrofit acres is small (e.g., less than 0.4% of watershed acres in Tier 2 and 1.8% in Tier 3), the per-acre cost is high compared to other sectors. Nevertheless, the average cost per household for the 4.9 million urban households in the watershed by 2010 is expected to be small, ranging from $12 in Tier 1 to $85 in Tier 3. These estimates assume that all costs are borne by urban households. However, federal and state cost share funds or other cost-saving opportunities might reduce these costs.

Total capital costs are $0.5 billion for Tier 1, $1.1 billion for Tier 2 and $3.2 billion for Tier 3. The distribution of capital costs across states is similar to the distribution of annual costs shown in Exhibit ES-8.

Onsite Waste Management System Costs (Septic Systems)

There are no onsite waste management system (OSWMS) costs for Tiers 1 and 2. This is because no existing onsite systems require an upgrade to a septic system with an advanced nitrogen removal capability in these two tier scenarios. Costs are minimal for Tier 3 because, as specified in this tier, only 1% of existing systems require upgrades or replacement. The annual cost for Tier 3 is $13 million and total capital costs equal $68 million. The average annual cost per household implementing the BMP is $1,020.

As noted above, this estimate does not include costs for new homes. The estimated annual cost for new homes is not included because: 1) developers have an opportunity to offset incremental OSWMS costs with savings in other construction costs, and 2) costs would be absorbed into the price of a new home mortgage. Furthermore, the per-system cost of $1,020 used in the cost analysis is for single system upgrades, whereas new homes built in developments will most likely have lower costs because they can use multi-home systems with lower average per-home costs.

Regional Economic Impacts Analyses

At the request of the Chesapeake Bay Program, EPA's National Center for Environmental Economics (NCEE) evaluated the socioeconomic impact of attaining revised water quality criteria, designated uses, and boundaries for the Chesapeake Bay and its tidal waters. The objective of this analysis is to estimate the economic impacts of both the direct and indirect effects of compliance. Measures of economic impacts include changes in the value of regional output, or goods produced, employment, as well as wages and income, which are indicative of the potential for widespread socioeconomic impacts.

Given the size of the regional economy ($1.4 trillion in personal income in 1999 in the 6-state area and the District of Columbia, including $574 billion in Bay counties; in 2001 dollars, the values become $1.5 trillion and $610 billion, respectively), net impacts over this area are not likely to be seen. For example, baseline gross regional product in the state of Maryland is forecast to grow by 37% by 2010, corresponding to 19% growth in employment and 17% growth in real disposable personal income. The Tier 3 scenario would result in a net increase in output, employment, and value added above baseline levels. The stimulus results from increased spending in high wage industries (e.g., wastewater treatment technologies) as well as an influx of funds for pollution controls (e.g., federal cost shares for agricultural BMPs). Not included are additional market benefits likely to result from improved water quality (e.g., commercial and recreational fishing industries). Therefore, the regional economy should expand as a result of the tier scenarios.

The estimated annual cost of Tier 3 for 2010 populations ($1.1 billion in 2001 dollars) represents 0.2% of personal income in the Bay counties in 1999. Even if all capital costs ($8.0 billion) for this scenario were incurred in one year, they represent only 1.4% of personal income in the Bay counties in 1999. Although these data indicate that the pollution controls specified in the tier scenarios will not result in substantial and widespread social and economic hardship, there may be localized areas that need funding priority or special considerations.

Screening-Level Impact Analysis

U.S. EPA (1995) guidance requires **multiple** analyses to determine whether costs to meet water quality standards will have a substantial financial impact on those responsible for paying the costs **and** a widespread social and economic impact on the community. The guidance recommends several tests to determine if compliance costs might have a substantial financial impact. For the widespread impact analysis, macroeconomic modeling is the best approach because it can show how incremental costs affect the sectors implementing controls and the sectors that receive revenues as a result of the expenditures. U.S. EPA conducted a macroeconomic analysis at a regional level for the UAA Workgroup. The results, as described above, indicate positive net impacts on regional output and employment because the expenditures occur in sectors that have higher regional output multipliers and employment-to-output ratios compared to the sectors incurring costs. In addition, the costs are small compared to the size of the regional economy ($1.4 trillion in personal income in 1999 in the 6-state area and the District of Columbia, including $574 million in Bay counties). This result illustrates the importance of considering the full range of economic impacts rather than focusing only on costs. It also shows that control costs may not have substantial **and** widespread adverse social and economic impacts at the watershed level.

Nevertheless, there may be localized areas that need funding priority. The UAA Workgroup developed a screening analysis to identify where the estimated costs of the tier scenarios would *no*t likely pose substantial and widespread social and economic hardship. And, although the tier scenarios are hypothetical constructs rather than actual programs developed by the jurisdictions in their tributary strategies, the Bay Program wanted to provide these screening results to jurisdictions as information or a starting point for their analyses. The screening analysis is provided in Part III. The 12 sector-related screening variables selected by the UAA Workgroup include:

- Agriculture: Average BMP costs/net cash return
- Agriculture: Crop plus portion of hay BMP costs/crop plus hay sales
- Agriculture: Livestock plus portion of hay BMP costs/livestock sales
- Agriculture: Average BMP costs/median household income
- Agriculture: Percent of county earnings from agriculture, agriculture services, food and kindred products, and tobacco sectors/total county earnings
- Forestry: Percent of county earning from forestry and logging/total county earnings
- Urban: Average BMP costs/median household income
- Onsite Treatment Systems: Average BMP costs/median household income
- Onsite Treatment Systems: Percent of households affected in county
- POTWs: Current household sewer rate plus average new household cost/median household income
- POTWs and Urban Combined: Total sewer costs (current plus new) plus average urban BMP cost/median household income
- Industrial: Percent of county earnings from industrial sectors containing affected facilities/total county earnings.

Depending on the sectors with which they are associated, the screening model variables indicate when control costs are small relative to household incomes or the local economy, and, therefore when substantial impacts are unlikely.

It is important to note that this screening analysis is just that; it does not provide conclusions about, for example, threshold values beyond which a more comprehensive analysis is warranted. It does not seek to determine where cost-share assistance may be most useful. Rather, the screening results only show the ranges of values of the different variables, and it is left up to the jurisdictions to evaluate this information.

POTW and Industrial Sources

Exhibit ES-9 shows the results of the screening analysis for the POTW sector, and lists the number of counties or independent cities with screening variables that exceed 1% as a result of costs that would be imposed under Tiers 2 and 3. For the POTW sector, the screening analysis consists of comparing total potential sewer bills to median household income, based on EPA (1995) guidance indicating that substantial impacts are unlikely when this ratio is less than 1%. Except for the District of Columbia, CSO and SSO costs are not included in this analysis.

Overall, variable values greater than 1% account for 15% of counties and cities under Tier 2, and 20% under Tier 3. Virginia has the largest number of counties, followed by Pennsylvania. These states also have the largest number of counties or independent cities in the analysis and, therefore, having the greatest number of counties with variable values above 1% is not necessarily indicative of having a high potential for impacts. In fact, the incidence of variable values exceeding 1% is greater in Delaware (1 out of 3 counties) and West Virginia (3 or 4 out of 11 counties) than either Virginia or Pennsylvania.

These results reflect capital cost-share provisions of 10% in Virginia and 50% in Maryland, which reduces the amount of costs borne by households in these states; no grant funds are assumed for other states or the District of Columbia. This approach is also based on EPA (1995) guidance, which indicates that sources of funding (e.g., federal and state grants and cost-share funds) should be considered in evaluating economic and social hardship conditions.

Exhibit ES-9: POTW Screening Analysis Results for Cumulative Costs

Jurisdiction (# Counties in Watershed)	Number of Counties with POTW Screening Variable > 1%	
	Tier 2	Tier 3
Delaware (3 of 3)	1	1
District of Columbia (1 of 1)	0	0
Maryland (24 of 24)	0	1
New York (19 of 62)	1	1
Pennsylvania (42 of 67)	5	8
Virginia (97 of 135)[2]	18	22
West Virginia (11 of 55)	4	4
Total (197)	29	37

1. The POTW variable is average cost per household divided by median household income. The average cost includes current household sewer fees plus incremental average household control costs for the tier scenario. Includes CSO costs for the District of Columbia.
2. Includes independent cities as well as counties.

Industrial point sources incur control costs under Tiers 2 and 3. The screening analysis identifies the relative county-level earnings derived from the industrial sector or sectors in which the point sources are classified. **Exhibit ES-10** lists the number of counties or independent cities by state for which the screening variable value in Tier 3 exceeds 5%. The remaining jurisdictions have variable values of less than 5% (and generally less than 1%), except for 8 counties for which the variable cannot be evaluated because of missing data, indicating that the affected sectors are not a large part of the local economy. may not . Note, however, that these values are not indicative of where control costs would pose hardship, but merely show the size of the sector containing a facility that may need to implement controls.

Exhibit ES-10: Industrial Screening Analysis Results for Cumulative Costs

Jurisdiction (# Counties in Watershed)	Number of Counties with Industrial Screening Variable > 5%[1]
Delaware (3 of 3)	0
District of Columbia (1 of 1)	0
Maryland (24 of 24)	2
New York (19 of 62)	0
Pennsylvania (42 of 67)	5
Virginia (97 of 135)[2]	4
West Virginia (11 of 55)	1
Total (197)	12

Exhibit ES-10: Industrial Screening Analysis Results for Cumulative Costs

Jurisdiction (# Counties in Watershed)	Number of Counties with Industrial Screening Variable > 5%[1]

1. The industrial screening variable is earnings in the affected sectors divided by total earnings. Results exclude 8 counties with missing earnings data for a sector that includes a substantial discharger; 1 county is in Maryland, 3 are in Pennsylvania, and 4 counties are in Virginia.
2. Includes independent cities as well as counties.

Agriculture

The screening analysis includes both a cost variable (based on identifying potential for substantial impacts) and an earnings variable for the agricultural sector that is similar to the earnings variable for industrial sources (as indication of whether impacts could be widespread). The cost variable compares (implied) average annual per-farm BMP costs to median household income. Because the screening analysis includes two variables, the results in **Exhibit ES-11** reflect the joint outcome of both variables.

EPA (1995) provides profitability tests of impacts for businesses. However, the agricultural industry as a whole is highly subsidized, which means that these sources are not typical private businesses, and EPA guidance for evaluating private sector business impacts may not be appropriate. Many agricultural producers do not meet the profitability requirement in EPA guidance (private sector entities must be profitable before implementing pollution controls in order for substantial impacts to result from such costs). However, data are not available to exclude individual unprofitable farms from the analysis. At the same time, the agricultural sector is not similar to municipalities, and so the public sector tests in EPA (1995) also do not apply. The screening variable comparing costs to household income provides information to supplement the private sector tests that compare costs to net cash return and sales, although interpretation of this mix of concepts is difficult (i.e., there is no benchmark for comparing business-related expenses to household income).

Exhibit ES-11: Agriculture Screening Analysis Results for Cumulative Costs

	Number of Counties with MHI Screening Variable > 1% and Farm and Related Earnings Screening Variable > 5%[1]		Number of Counties with MHI Screening Variable > 1% and Farm Only Earnings Screening Variable > 5%[1]	
Jurisdiction (# Counties in Watershed)	Tier 2	Tier 3	Tier 2	Tier 3
Delaware (3 of 3)	1	1	0	0
District of Columbia (1 of 1)	0	0	0	0
Maryland (24 of 24)	1	1	0	0
New York (19 of 62)	2	2	0	0
Pennsylvania (42 of 67)	8	8	0	0
Virginia (97 of 135)[2]	9	10	5	5
West Virginia (11 of 55)	1	1	1	1

Exhibit ES-11: Agriculture Screening Analysis Results for Cumulative Costs

Jurisdiction (# Counties in Watershed)	Number of Counties with MHI Screening Variable > 1% and Farm and Related Earnings Screening Variable > 5%[1]		Number of Counties with MHI Screening Variable > 1% and Farm Only Earnings Screening Variable > 5%[1]	
	Tier 2	Tier 3	Tier 2	Tier 3
Total (197)	22	23	6	6

1. The MHI screening variable is average BMP cost per farm household divided by median household income. Note that this variable represents a mix of private sector and public sector concepts (i.e., business-related expenses compared to household income), and may be difficult to interpret. The earnings screening variable is earnings in farm and related sectors divided by total earnings in the first set of results and farm income only in the second set of results. The related sectors include farm services, tobacco products, and food and kindred products manufacturing.
2. Includes independent cities as well as counties.

Further, there is great uncertainty in the extent of costs that will actually be borne by farmers. The 2002 Farm Bill increases federal overall conservation funding by 80% above the level committed by the last (1996) farm bill. In addition, the new law permits a greater percentage of BMP installation costs (90%, up from 75% in the 1996 bill) to be granted to limited-resource farmers under the Environmental Quality Incentives Program. The 2002 Farm Bill cost share provisions are not reflected in this economic analysis. Therefore, costs paid by farmers may be lower than those used in the screening analysis, and impacts may be overstated. As one example, although specific provisions for the yield reserve BMP in the tier scenarios are not included in the bill, the program may be funded under an innovative technologies clause of the bill (personal communication with T. Simpson, Chair, Chesapeake Bay Program Nutrient Subcommittee, May 2002). If implemented, this cost-share program could result in annual incentive payments of $20 to $40 per acre that are not included in the screening analysis. Funding for this program alone would reduce the agricultural costs borne by farmers in Tier 3 by $17 million to $42 million per year.

Also, due to the large number of programs and sources across states, the cost-share information may be incomplete. The cost-share assumptions in the impact analysis are very complex because they vary by state, program, and BMP. Cost shares may include a variety of contract arrangements including a capital cost share, an annual rental payment, an up-front incentive payment, and an annual maintenance cost. For this analysis, the Chesapeake Bay Program did not factor in the substantial annual rental payments but instead assumed that they would offset any revenue losses resulting from BMP implementation. If instead, rental payments more than offset any losses (e.g., BMPs are implemented on marginal land such that little revenue is lost), the screening analysis may overstate impacts.

As shown in Exhibit ES-11, under Tier 2, there are 22 counties that do not have MHI and earnings screening variable values below the values shown. This result uses the earnings screening variable for farm income and related sectors. When this variable is limited to farm income only, only 5 counties in Virginia and one county in West Virginia have values that exceed the values shown for both screening variables.

Under Tier 3, 23 counties have high values for both screening variables. These results are nearly identical to Tier 2 results despite BMP cost increases. This happens because the earnings screening variable is constant across the tier scenarios. Thus, even if higher costs increase the likelihood of substantial impacts in some counties, the farming sector's small contribution to the local economy limits its ability to have a widespread adverse impact measured by impacts on overall county incomes.

Forestry

The screening analysis for forestry impacts uses an earnings variable that compares forestry sector earnings to total earnings. No counties or independent cities are likely to experience hardship as a result of forestry BMPs because forestry represents a small share (less than 3%) of earnings in all jurisdictions. The small values indicate that the sector is small relative to the county economy and, therefore, a sector-level substantial impact (if any) is unlikely to have widespread ramifications.

Urban

Like the POTW sector, the screening analysis consists of comparing average annual per-household costs to median household income, based on EPA (1995) guidance for evaluating substantial impacts. Few counties exceed a 1% ratio value under Tier 2 (**Exhibit ES-12**). Under Tier 3, 162 out of 197 jurisdictions still have a small screening variable value (i.e., < 1%), despite a substantial increase in annual BMP costs.

Exhibit ES-12: Urban Screening Analysis Results for Cumulative Costs

Jurisdiction (# Counties in Watershed)	Number of Counties with Urban Screening Variable > 1%[1]	
	Tier 2	Tier 3
Delaware (3 of 3)	0	0
District of Columbia (1 of 1)	0	0
Maryland (24 of 24)	1	1
New York (19 of 62)	0	4
Pennsylvania (42 of 67)	3	9
Virginia (97 of 135)[2]	4	19
West Virginia (11 of 55)	0	2
Total (197)	8	35

1. The urban screening variable is average household BMP costs divided by median household income. Does not include CSO/SSO costs.
2. Includes independent cities as well as counties.

Urban households may incur costs for urban BMPs as well as POTW controls. Under these combined costs, 145 jurisdictions have variable values of less than 1% (**Exhibit ES-13**). The remaining 52 areas with higher variable values for combined costs require further analysis to evaluate impact potential.

Under Tier 3, the screening analysis shows that variable values for combined costs are less than 1% in 117 jurisdictions. Further analysis would be needed for the 80 areas that have higher screening variable values.

Exhibit ES-13: Urban and POTW Combined Screening Analysis Results for Cumulative Costs

Jurisdiction (# counties in watershed)	Number of Counties with Combined Screening Variable > 1%[1]	
	Tier 2	Tier 3
Delaware (3 of 3)	1	1
District of Columbia (1 of 1)	0	0
Maryland (24 of 24)	5	8
New York (19 of 62)	4	8
Pennsylvania (42 of 67)	13	22
Virginia (97 of 135)[2]	26	36
West Virginia (11 of 55)	3	5
Total (197)	52	80

1. The combined cost screening variable is average urban BMP and POTW costs per household divided by median household income. Includes CSO costs for the District of Columbia.
2. Includes independent cities as well as counties.

Onsite Waste Management Systems

Similar to the agriculture sector, the screening analysis for OSWMS costs includes both a cost variable (designed to identify whether impacts would be substantial) and a variable for the percent of households affected (designed to identify whether impacts would be widespread). The cost variable compares average annual per-household BMP costs to median household income. The results indicate that, because the onsite waste management BMP affects so few households (less than 1% of existing onsite systems), there is little potential for any substantial financial impacts to also be widespread.

Introduction

In developing revised water quality criteria, designated uses, and boundaries for those uses to protect living resources in the Chesapeake Bay and its tidal waters, EPA's Chesapeake Bay Program Office prepared a technical support document (*Technical Support Document*; U.S. EPA Chesapeake Bay Program. 2003. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability*). The document provides information to Chesapeake Bay jurisdictions for development of water quality standards for dissolved oxygen, clarity, and chlorophyll *a*, based on EPA's regional criteria guidance. Part of the jurisdictions' water quality standards development process may be to conduct use attainability analyses (UAAs). The information contained in the *Technical Support Document* is to assist states in development of their individual UAAs, and serves as a basis for state-specific documents that will be initiated after the revised criteria for the Chesapeake Bay are finalized by EPA.

This document supplements the *Technical Support Document* by presenting economic analyses performed by the Chesapeake Bay Program. Part I of this document provides estimates of the potential control costs associated with three modeling scenarios (the tier scenarios) of nutrient reduction measures. Part II describes economic modeling of the potential impacts of these control costs in the Bay region. Part III documents a screening-level analysis of potential impacts, also based on the costs of the tier scenarios. Several appendices provide additional information. Appendix A summarizes the types of benefits that may arise from the tier scenarios, and existing studies related to Bay water quality. Appendix B presents detailed calculations supporting the screening analysis. Appendix C provides detailed results from the screening analysis in tabular format, and Appendix D provides additional results in map format. Appendix E contains three case study sensitivity analyses of the screening analysis results related to potential costs for combined sewer overflows. Appendix F includes information related to evaluating impacts associated with potential pollutant loading caps for publicly owned treatment works. Finally, Appendix G provides information related to sanitary sewer overflows submitted in comments on the draft economic analyses.

The economic analyses provide information related to evaluating impacts from the implementation of the nutrient reduction measures defined in the *Technical Support Document*. However, the Bay Program did not use these analyses to delineate boundaries for the new refined designated uses. Although this information may be useful to states in developing their own UAAs, economic analyses to show substantial and widespread impacts from meeting water quality standards would need to be more rigorous than the analyses performed by the Bay Program. Direction regarding the types of information and analyses necessary to perform a UAA is included in Part III of this document.

The *Technical Support Document* and this economics document do not represent a regulation or a mandatory requirement, but rather provide a compilation of the basin-wide, UAA-related analyses assimilated collaboratively by the affected jurisdictions. EPA encourages the jurisdictions to use the information in this document and, when appropriate, to perform additional analyses tailored to each jurisdiction during their respective water quality standards development process. The Chesapeake Bay Program's analyses address all dischargers and sources in the watershed needing controls to meet the new refined designated uses, as modeled under three hypothetical control scenarios. Local jurisdictions can use more site-specific control and cost information, and evaluate local economic impacts.

Part I: Documentation of Estimated Costs of the Tier Scenarios

As part of its assessment of actions to remove the Chesapeake Bay and its tidal tributaries from the list of impaired waters under the Clean Water Act, U.S. EPA's Chesapeake Bay Program Office estimated the costs and nutrient (nitrogen and phosphorus) reduction potential of nutrient removal technology and best management practices under several alternative scenarios. This report summarizes the purposes, methods, and results of the cost assessment. Note that sediment reduction is not specifically addressed, unless it is included in the removal practices. Control of air sources is also not addressed in the scenarios.

1. Background and Objectives

As described in the *Technical Support Document*, the Chesapeake Bay Program developed tiered implementation scenarios of nutrient reduction measures for the Chesapeake Bay watershed based on the extent of controls already in place as of the year 2000 (the 2000 Progress scenario), and estimates of the controls that would be in place if current implementation rates were continued through the year 2010 (the Tier 1 scenario). Then, Tiers 2, 3, and E3 (which represents a theoretical limit of technology, but is physically implausible) scenarios add incremental increases in implementation levels. The tier scenarios, developed by various stakeholder workgroups, are based on the Chesapeake Bay Program's estimates of 2010 populations and land uses in the basin. This report provides estimates of the cost of Tiers 1, 2, and 3.[1] Note that these cost estimates reflect, in part, the extent of efforts to date which vary across states. However, state data on controls in place throughout the watershed are incomplete, which may result in overestimates of costs for the tiers.

This report provides estimates of the total annual cost of achieving the tier scenarios, total capital cost requirements, and, to the extent that information could be compiled, estimates of how these costs may be shared between the public and private sectors. For example, the Chesapeake Bay Program assumed that current agricultural cost-share and incentive payments are continued (i.e., there are no limits in program funding). Similarly, it assumed that the states of Maryland, and Virginia to a lesser extent, would provide grants to assist in funding nutrient reduction technologies for publicly owned treatment works. Costs for the remaining practices specified in the tier scenarios are attributed to the private sector (although public programs could be used to fund these controls as well).

In addition to summarizing the resources required for each level of control implementation, the cost estimates can also be used to investigate the potential economic impacts of the scenarios. The Chesapeake Bay Program's Use Attainability Analysis (UAA) Workgroup used these estimates to develop screening-level impact analyses based on the same assumptions described above regarding how costs may be shared between the public and private sectors (see Part III).

[1] No cost estimates were developed for the E3 scenario which the Chesapeake Bay Program regards as physically implausible.

U.S. EPA also used the estimates in a regional economic impact analysis for the UAA Workgroup.

Part I of this report is organized as follows. Section 2 describes the methods for estimating the cost of nutrient reduction technologies for point sources and best management practices (BMPs) for nutrient control. Section 3 summarizes results, including capital and total annual costs, by political and hydrogeologic boundaries.

2. METHODS

The sections below describe the methods for estimating the costs of the tier scenarios for POTW and industrial sources (Section 2.1) and agriculture, forestry, urban, and onsite waste management system sources (Section 2.2).

2.1 POTWs and Industrial Sources

The Chesapeake Bay Program convened a multi-stakeholder Nutrient Removal Technology (NRT) Task Force to develop point source costs for the tier scenarios. The Task Force's method and estimated costs are described in detail under separate cover (NRT Cost Task Force, 2002), and summarized below.

The NRT Task Force developed costs for significant municipal and industrial facilities located in the watershed that discharge nitrogen and phosphorus. Significant municipal facilities are generally defined as wastewater treatment plants that discharge flows of 0.5 million gallons per day (mgd) or greater, although the threshold may vary slightly from jurisdiction to jurisdiction. Significant industrial facilities are those discharging nutrient loadings greater than or equal to those discharged by a municipal wastewater treatment with a flow capacity of 0.5 mgd, which equates to approximately 75 lbs/day of total nitrogen (TN) and 25 lbs/day total phosphorus (TP) based on a municipal discharge of 18 mg/L TN and 6 mg/l TP.

2.1.1 Point Source Nutrient Reduction Scenarios

The tier scenarios incorporate varying levels of nutrient reductions for point sources. For municipal facilities, Tier 1 includes current or planned pollutant controls; Tier 2 requires end-of-pipe effluent concentrations of 8.0 mg/L TN, and either 1.0 mg/L TP or the permit limit (whichever is lower); and Tier 3 requires end-of-pipe effluent concentrations of 5.0 mg/L TN, and the lower of 0.5 mg/L TP or the permit limit. For industrial facilities, Tier 1 represents no change from current levels, and the effluent concentrations required for Tiers 2 and 3 generally correspond to those of municipal facilities. Tier 1 also includes a reduction in combined sewer overflows (CSOs) in the District of Columbia. **Exhibit 1** provides a summary of the tier scenarios for municipal and industrial facilities and the District of Columbia CSOs.

Exhibit 1: Scenarios of Nutrient Reduction for Point Sources

Source	Tier 1	Tier 2	Tier 3
Significant Municipal Wastewater Treatment Facilities (as of 2000)	Existing NRT facilities and those planned to go to NRT by 2010: 2010 flow with 8.0 mg/L TN effluent concentration and year 2000 concentrations of TP. For all remaining facilities: 2010 flow with year 2000 TN and TP concentrations.	Reach and maintain 8.0 mg/L TN and 1.0 mg/L TP effluent concentrations at 2010 flows at all facilities. (Phosphorus concentration is 1.0 mg/L or permit limit, whichever is more stringent.)	Reach and maintain 5.0 mg/L TN and 0.5 mg/L TP effluent concentrations at 2010 flows at all facilities. (Phosphorus concentration is 0.5 mg/L or permit limit, whichever is more stringent.)
Significant Industrial Wastewater Treatment Facilities (as of 2000)	Maintain current levels or permit conditions if less.	Generally a 50% reduction from Tier 1, or 2000 concentrations or permit conditions if less.	Generally a 80% reduction from Tier 1, or 2000 concentrations or permit conditions if less.
Non-significant Municipal Wastewater Treatment Facilities (as of 2000)	Maintain current TN/TP concentrations with 2010 flows.	Maintain current TN/TP concentrations with 2010 flows.	Maintain current TN/TP concentrations with 2010 flows.
Combined Sewer Overflow (CSO) (District of Columbia only)	43% reduction in CSO.	43% reduction in CSO.	43% reduction in CSO.

Note that for municipal facilities, TN and TP concentrations may increase from one tier to the next. For example, concentrations for some facilities increase between 2000 Progress and Tier 1 because the NRT Task Force believes that some facilities may not be able to operate as efficiently at 2010 flows as they do at 2000 flows and, therefore, the 2000 concentration may not be representative of 2010 conditions. For facilities with TN concentrations less than 8 mg/L in 2000, the Task Force assumed concentrations would increase to 8 mg/L by 2010. The same principle is true for TP (i.e., the Task Force assumed concentrations would increase to 1 mg/L by 2010 if the 2000 concentration is less than 1 mg/L).

2.1.2 Overview of Method

The NRT Task Force developed costs for controlling nitrogen and phosphorous separately using estimates obtained directly from affected facilities, where available, and applying the methods described below if facilities did not provide estimates. However, for Tier 1, which represents current or planned controls, costs are zero for municipal facilities that did not provide costs. There are also no costs for industrial facilities under Tier 1, since it represents no change from 2000 effluent concentrations. In addition, the costs of upgrades for federal facilities are excluded from the analysis, because households in the watershed will not incur direct costs for these facilities.

The NRT Task Force developed estimates for capital and annual operating and maintenance (O&M) costs. This report also provides these estimates annualized over 20 years. For municipal facilities, the annualized estimates reflect an average 2001 Statewide Revolving Fund rate for each state (1.0% for DE, 2.2% for MD, 2.5% for NY, 2.5% for PA, 3.9% for VA, and 0.7% for WV) and the national average rate of 2.4% (U.S. EPA, 2001c) for the District of Columbia. For industrial facilities, the annualized estimates reflect a 5.76% interest rate.[2] The summary of estimates in this report also incorporates the assumption (based on current experience) that federal and state grant programs would contribute 50% of capital costs for NRT for municipal facilities in Maryland, 10% for municipal facilities in Virginia, and 0% for facilities in other states and the District of Columbia.

2.1.3 Nitrogen Removal: Municipal Facilities

As described above, there are only Tier 1 costs for municipal facilities for the removal of nitrogen if these facilities are either currently operating NRT or are planning to by 2010 and have not already obtained funds for their efforts. Costs for facilities are estimated from data obtained directly from facilities or by applying an estimating methodology developed by the NRT Cost Task Force. The methods for estimating costs for Tiers 2 and 3 for nonreporting facilities (i.e., those that did not provide estimates) are described below.

Tier 2. The NRT Task Force used capital cost estimates received from reporting municipal facilities, including all facilities with design flow greater than 30.0 mgd. For the remaining facilities, since the nitrogen removal goals for municipal facilities in Tier 2 are the same as those for Tier 1 (8 mg/L TN), the Task Force used capital cost estimates for upgrading 67 facilities provided by U.S. EPA to extrapolate costs for upgrading nonreporting facilities to Tier 2 requirements. The estimates are based on actual construction costs, engineering design estimates, or preliminary engineering reports and facilities plans. The NRT Task Force fit a line to these data and estimated the following capital costs equation:

$$\textit{Capital Cost} = 2{,}023{,}829 + 7 - 4{,}351.8039 \times Q - Q^2$$

where Q = design flow between 0.5 and 30.0 mgd.

To estimate O&M costs, the NRT Task Force assumed that only facilities with ammonia concentrations greater than 2 mg/L would require additional nitrification to convert ammonia-N to nitrate-N. Most of the operations costs for Tier 2 are associated with the change in electrical requirements for aeration during biological treatment. The nitrification process requires oxygen, specifically, 4.57 lbs of oxygen per pound of ammonia nitrogen removed. Thus, the oxygen requirement can be calculated given a plant's effluent ammonia concentration. Once the oxygen requirement is known, the brake horsepower can be calculated using operating parameters for a typical aeration system.

The O&M costs also account for the possible denitrification energy cost savings due to lower oxygen requirements. The Task Force calculated electrical costs assuming 2.86 pounds of oxygen saved per pound of nitrate denitrified. In calculating nitrification and denitrification O&M costs, the Task Force used the projected 2010 flow rate. Change in solids production is

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[2] The 5.76% interest rate is based on the average market rate between 1998 and 2002 for business loans of between $100,000 and $10,000,000 (Federal Reserve, 2002, 2001, 2000, 1999, 1998), and a marginal corporate tax rate of 20%. The average interest rate over the last five years is approximately 7.2%. Because loan repayments reduce corporate tax liability, the net interest rate on a loan reflects this tax advantage, which is 80% of the stated rate (i.e., 1–20%). Thus, the effective interest rate is 5.76% (7.2% x 0.8).

negligible, and no additional labor is required. Maintenance costs are estimated as 2% of initial capital costs per year.

Tier 3. The NRT Task Force acknowledged certain improvements to a standard activated sludge plant would be necessary to achieve TN levels of 5 mg/L, and made the following assumptions:

- Plants are currently achieving TN of 8 mg/L
- Additional treatment comprises secondary anoxic zone with methanol addition following aeration and improvements to nitrification, clarification, flow splitting, and aeration
- Incremental costs include 30% program implementation associated with engineering, construction management, legal, bonding, and administrative fees.

The NRT Task Force fit lines to capital cost pollutant control estimates for plants with capacities of 0.1, 1.0, 10 and 30 mgd to develop separate cost curves:

0.1 mgd < Q < 1.0 mgd
$$Capital\ Cost = 967.06 \times Q + 144.44$$
1.0 mgd < Q < 30 mgd
$$Capital\ Cost = 386.01 \times Q + 864.83$$

The Task Force used a similar method to estimate O&M costs, using plant capacities of 0.1, 1.0, 10 and 30 mgd to develop linear cost curves. O&M costs include methanol purchase, handling, stabilization, and disposal or reuse costs from increased solids production, energy, and maintenance costs, and include the following assumptions:

- 3.1 pounds of methanol are needed for every pound of nitrate reduced
- Methanol costs are $1.00 per gallon for bulk storage, except for the 0.1 mgd plant where costs are $2.00 per gallon for a 55-gallon drum feed
- The process will yield 0.12 pounds of solids per pound of methanol applied
- Solids handling, stabilization and disposal or reuse costs are $300 per dry ton
- Energy costs for mixing and other uses for each plant size are $0.05/kWh
- Maintenance costs are 2% of initial capital costs.

2.1.4 Nitrogen Removal: Industrial Facilities

The industrial cost estimates are described in detail in NRT Cost Task Force (2002). As described above, there are no reductions in nitrogen from industrial facilities required under Tier

1. In general, Tier 2 reflects levels of reduction on the order of 50% from Tier 1 unless permit conditions are more stringent. Tier 3 reflects a reduction of about 80% beyond Tier 1 unless permit conditions are more stringent. For Tiers 2 and 3, the NRT Task Force developed costs based on 2000 effluent concentrations. The Task Force used site-specific cost estimates where they were provided; otherwise, it assumed that onsite controls or transportation of effluent to a POTW would be required. Estimated costs for Tiers 2 and 3 are zero whenever 2000 TN or TP concentrations are less than or approximately equal to the concentrations required by each tier. For the remaining facilities, the Task Force estimated costs using the same methodology as for municipal facilities, even where it is known that some industrial wastewater is not treatable biologically.

2.1.5 Phosphorus Removal: Municipal Facilities

As described above, there are only costs for municipal facilities for the removal of phosphorus if these facilities provided estimates for current or planned controls. The methods for estimating costs for Tiers 2 and 3 for facilities that did not provide estimates are described below.

Tier 2. The NRT Task Force developed costs based on 2000 TP effluent concentrations. Costs are zero for facilities with effluent already below the Tier 2 requirement of 1 mg/L TP. The Task Force assumed that facilities discharging between 1 mg/L and 2 mg/L TP are operating chemical precipitation, and would only require O&M costs associated with increased chemical addition and sludge handling. Removal of 1 mg/L of TP requires 14.4 mg/L of alum, which costs $269 per ton. Sludge handling costs are $300 per dry ton of sludge. The amount of sludge produced is calculated from the stoichiometric coefficients of the sludge reaction and the 2010 flow rate. Facilities discharging TP concentrations greater than 2 mg/L require treatment controls. The NRT Task Force assumed that facilities would install chemical precipitation using alum. Cost curves for chemical precipitation installation are:

$0.1 \text{ mgd} < Q < 1.0 \text{ mgd}$
$\textit{Capital Cost} = 94{,}444 \times Q + 65{,}556$
$1.0 \text{ mgd} < Q < 30 \text{ mgd}$
$\textit{Capital Cost} = 15{,}172 \times Q + 144{,}828$

The Task Force approximated costs for plants with capacities outside of this range using the maximum or minimum cost; it calculated O&M costs using the method for facilities discharging between 1 mg/L and 2 mg/L TP, and assumed maintenance costs of 2% of capital costs per year.

Tier 3. The NRT Task Force made the following assumptions in developing costs:

- Tier 2 requirements are already in place (i.e., facilities are already operating chemical precipitation), therefore, there are no additional capital costs

- Facilities are operating at 1.0 mg/L TP or less

- O&M costs are calculated as described in Tier 2.

2.1.5 Phosphorus Removal: Industrial Facilities

As described above, there are no reductions in phosphorus from industrial facilities required under Tier 1. For Tiers 2 and 3, the NRT Task Force estimated TP removal costs using the same methodology used to estimate TN removal costs.

2.1.6 Limitations and Uncertainties in the Analysis of Point Source Costs

There are a number of limitations and uncertainties inherent in the method for estimating point source costs. **Exhibit 2** illustrates the sources of potential bias, and the potential impact on the estimates.

Exhibit 2: Sources of Uncertainty in the Point Source Cost Estimates

Source	Potential Impact on Costs	Comments
Costs for reducing TN and TP derived separately	+	Some technologies may control TN and TP simultaneously; thus costs could be lower to treat N and P at the same time
Costs may include growth-related costs not related to the tier scenarios	+	Planning-level estimates for 2010 may incorporate costs that would be incurred anyway to serve increased populations; no attempt is made to estimate baseline costs [upgrades necessary to treat 2010 flows sufficient to meet local water quality standards or anticipated total maximum daily loads (TMDLs) without implementation of the tier scenarios]
Costs include estimates provided by facilities for which no nutrient reductions are indicated	+	Current effluent concentrations for these facilities meet the levels specified in the tier scenarios
Costs for NRT obtained from facilities	?	These estimates have not been verified.
Costs include biological treatment to reduce TN and TP at many industrial facilities	?	Biological treatment may not be a feasible option for certain industrial facilities, and more or less costly treatment controls may be needed instead
Estimates based on cost equations reflect the same treatment to reduce TN and TP levels at all facilities	?	Costs are not based on facility-specific treatment processes or operational procedures and, therefore, may over- or underestimate costs

+ = assumption results in overestimating costs
? = impact of assumption on cost estimates is unknown

2.2 Forestry, Agriculture, Urban, and OSWMS Sources

The tier scenarios also include varying implementation levels of nutrient reduction BMPs for agricultural operations, forest harvesting operations, urban and mixed open (land with herbaceous cover not classified as agricultural, urban, or forest) land, and onsite wastewater management systems (OSWMSs). Tier 1, which represents current implementation levels extended to 2010, incorporates the Phase I and Phase II Storm Water Rules and other ongoing state and local programs (e.g., nutrient management planning on crop and hay land in Maryland

and Delaware). However, as described below, the degree to which it incorporates anticipated revisions to the concentrated animal feeding operation (CAFO) regulations and state programs submitted under the Coastal Zone Reauthorization Amendments (CZARA) of 1990 is unknown. **Exhibit 3** summarizes the tier scenarios for these sources.

U.S. EPA anticipates that CAFOs will incur costs to implement or improve animal waste management systems, develop and implement nutrient management plans, and transfer excess manure offsite under revisions to the effluent guidelines for this sector. However, because EPA is still finalizing the CAFO rule, the extent of overlap with the tier scenarios is unknown. For instance, although Tier 1 requirements for animal waste systems indicate continuing the level of implementation based on the average rate of 1997-2000 (Exhibit 3), this level is most likely lower than would be required under the final CAFO regulations.

Section 6217 of the CZARA requires 29 states and territories, including the basin states of Delaware, Maryland, New York, Pennsylvania, and Virginia, to develop programs to implement practices to control nonpoint source pollution in areas where land and water uses have a significant impact on coastal waters. Although state program were supposed to be approved by 1995 and fully implemented by 1999, this schedule has not been met. Administrative changes in 1998 required that participating states submit 15-year program strategies outlining the NPS management measures they plan to implement through a sequence of 5-year an implementation plans that coordinate BMP implementation with other programs such as the Chesapeake Bay Program. Management measures can differ by state depending on the relative impact of different types of NPS on water quality. Thus, BMP implementation that would occur under Section 6217 of CZARA may overlap the tiers to an unknown degree for the following controls:

- Agricultural BMPs, including forest riparian buffers, nutrient management plans, animal waste management, excess manure removal, stream protection, grazing land protection, conservation tillage, wetland restoration, and retirement of erodible land

- Silvicultural BMPs, including forest harvesting practices to reduce erosion

- Urban BMPs, including environmental site design and urban riparian forest and grass buffers

- Onsite disposal system BMPs, including denitrification.

Exhibit 3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources

BMP	Tier 1	Tier 2	Tier 3
Agriculture: Cropland Conversions to Forest or Hayland			
Forest buffers (Pasture)	Continue current level of implementation using average rate of 1997-2000. Includes fencing.	Increase level of implementation up to a total of 20% of the remaining stream reaches in pasture. Includes fencing.	Increase level of implementation up to a total of 30% of the remaining stream reaches in pasture. Includes fencing.
Forest buffers (Cropland)	Continue current level of implementation using average rate of 1997-2000.	Increase level of implementation up to a total of 20% of the remaining stream reaches in cropland.	Increase level of implementation up to a total of 30% of the remaining stream reaches in cropland.
Grass buffers (Cropland)	Continue current level of implementation using average rate of 1997-2000.	25% of remaining stream reaches within cropland.	50% of remaining stream reaches within cropland.
Forest buffers (Hayland)	Continue current level of implementation using average rate of 1997-2000.	25% of remaining stream reaches within hayland over Tier 1.	50% of remaining stream reaches within hayland over Tier 1.
Wetland restoration (Cropland)	Continue current level of implementation using average rate of 1997-2000.	Increase level of implementation up to a total of 33% of the remaining goal.	Increase level of implementation up to a total of 66% of the remaining goal.
Retirement of highly erodible land (HEL)	Continue current level of implementation using average rate of 1997-2000.	Retirement of HEL-Wetland Restoration-buffers (combined) comprise 10% of cropland within each county.	Retirement of HEL-Wetland Restoration-buffers (combined) comprise 15% of cropland within each county.
Carbon sequestration	Not applicable.	Not applicable.	Applied to 15% of remaining E3 cropland after land conversion programs applied.
Agriculture: BMPs on Cropland			
Conservation tillage	Continue current level of implementation using average rate of 1997-2000.	Applied to 30% of remaining cropland beyond Tier 1.	Applied to 60% of remaining cropland beyond Tier 1.
Farm plans (soil conservation and water quality plans)	Continue current level of implementation using average rate of 1997-2000.	Applied to 30% of remaining agricultural land (crop, hay, pasture) beyond Tier 1.	Applied to 70% of remaining agricultural land (crop, hay, pasture) beyond Tier 1.
Cover crops	Continue current level of implementation using average rate of 1997-2000.	Applied to 40% of remaining cropland beyond Tier 1.	Applied to 75% of remaining cropland beyond Tier 1.

Exhibit 3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources

BMP	Tier 1	Tier 2	Tier 3
Nutrient management plan implementation	MD & DE: 100% of cropland and hayland. Other basin states: Continue current level of implementation using average rate of 1997-2000.	MD & DE: 100% of cropland and hayland. Other basin states: Applied to 30% of remaining cropland and hayland beyond Tier 1.	MD & DE: 100% cropland and hayland. Other basin states: Applied to 30% of remaining cropland and hayland beyond Tier 2.
Yield reserve	Not applicable.	Not applicable.	Applied to 30% of the cropland and hayland under nutrient management. Replaces nutrient application component of nutrient management plan.
Excess manure removal	Assume alternative use for excess manure.	Assume alternative use for excess manure.	Assume alternative use for excess manure.
Animal waste management systems	Continue current level of implementation using average rate of 1997-2000.	Applied to 25% of remaining confined animal units beyond Tier 1 (combines storage system and barnyard runoff controls).	Applied to 60% of remaining confined animal units beyond Tier 1 (combines storage system and barnyard runoff controls).
Stream protection without fencing	Continue current level of implementation using average rate of 1997-2000.	Applied to 10% of remaining stream reaches within pasture land beyond Tier 1.	Applied to 25% of remaining stream reaches within pasture land beyond Tier 1.
Stream protection with fencing	Continue current level of implementation using average rate of 1997-2000.	Applied to 15% of remaining stream reaches within pasture land beyond Tier 1.	Applied to 75% of remaining stream reaches within pasture land beyond Tier 1.
Grazing land protection	Continue current level of implementation using average rate of 1997-2000.	Applied to 25% of remaining pasture land beyond Tier 1.	Applied to 50% of remaining pasture land beyond Tier 1.
Forestry			
Forest harvesting BMPs (erosion control)	Forestry BMPs are properly installed on 80% of all harvested lands.	Forestry BMPs are properly installed on 90% of all harvested lands.	Forestry BMPs are properly installed on 100% of all harvested lands with no measurable increase in nutrient and sediment discharge.
Urban and Mixed Open Land			
Urban land conversion (signatories only)	Full 2000-2010 urban land conversion based on 2010 population.	2000-2010 urban conversion – reduced 10% (acres "returned" as 65% forest, 20% mixed open, 15% agriculture).	2000-2010 urban conversion – reduced 20% (acres "returned" as 65% forest, 20% mixed open, 15% agriculture).

Exhibit 3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources

BMP	Tier 1	Tier 2	Tier 3
Urban and Mixed Open Land (Continued)			
Storm water management and low impact development – new development (2001-2010)	66% of new development has storm water management (percent reduction: TN=35, TP=45, TSS=80).	75% of new development has storm water management. 25% of new development employs environmental site design and low-impact development techniques. Efficiencies represent a 75%/25% weighted average reduction (TN=40, TP=55, TSS=85).	50% of new development has storm water management. 50% of new development employs environmental site design and low-impact development techniques. Efficiencies represent a 50%/50% weighted average reduction (TN=45, TP=57, TSS=87).
Storm water management - recent development (1986-2000)	60% of recent development has storm water management (percent reduction: TN=27, TP=40,TSS=65).	60% of recent development in MD, PA, DC, VA has storm water management (percent reduction: TN=27, TP=40,TSS=65).	60% of recent development in MD, PA, DC, VA has storm water management (percent reduction: TN=27, TP=40,TSS=65).
Storm water retrofits – recent (1986-2000) and old (pre 1986) development	0.8% of recent and old (pre 1986) development is retrofitted (percent reduction: TN=20, TP=30,TSS=65).	5% of recent and old (pre 1986) development is retrofitted (percent reduction: TN=20, TP=30,TSS=65).	20% of recent and old (pre 1986) development is retrofitted (percent reduction: TN=20, TP=30,TSS=65).
Urban nutrient management	Continue to implement BMP at average annual rate through 2010, using average of 1997-2000 (percent reduction: TN=17%, TP=22%).	40% of urban pervious and mixed open lands are under nutrient management (percent reduction: TN=17%, TP=22%).	75% of urban pervious and mixed open lands are under nutrient management (percent reduction TN=17%, TP=22%).
Grass buffers (urban land)	All urban stream reaches are assumed to have either grass or tree buffers. Where urban disturbance has altered a stream reach beyond repair/ restoration, it is not included as a potential buffer area.	Reduce grass buffers by 10% below Tier 1 level (conversion to forest buffers).	Reduce grass buffers by 30% below Tier 1 level (conversion to forest buffers).
Forest buffers (urban land)	Not applicable.	Increase forest buffer acreage by the same amount of "reduced" grass buffer acreage.	Increase forest buffer acreage by the same amount of "reduced" grass buffer acreage.
Forest buffers (mixed open land)	Continue current level of implementation using average rate of 1997-2000.	Increase forest buffer acreage by the same amount as forest buffers on urban pervious.	Increase forest buffer acreage by the same amount as forest buffers on urban pervious.

Exhibit 3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources

BMP	Tier 1	Tier 2	Tier 3
Onsite Treatment Systems			
Denitrification with pumping (new systems, i.e., post 2000)	Maintain current concentration/load per system (36 mg/l TN).	10% of new treatment systems will meet a concentration for nitrogen of 10 mg/L TN per system at the edge-of-the adsorption field. Remaining systems meet existing concentration/load levels.	100% of new treatment systems will achieve 10 mg/L TN at the edge of the adsorption field.
Denitrification with pumping (existing systems, i.e., pre-2001)	Maintain current concentration/load per system (36 mg/l TN).	Maintain current concentration/load per system (36 mg/l TN).	1% of existing (per year) treatment systems will achieve 10 mg/L TN at the edge of the adsorption field (1% represents failed systems and opportunities for upgrades). Remaining systems maintain existing concentrations/loads.

HEL = Highly erodible land
TN = total nitrogen
TP = total phosphorus
TSS = total suspended solids.

Exhibit 4 provides the number of incremental acres of each BMP or number of systems for onsite wastewater management systems (i.e., beyond acres or systems in the 2000 Progress scenario) that correspond to the scenario descriptions in Exhibit 3. Negative numbers indicate that BMP implementation is currently greater in the Progress 2000 scenario than required by the tier scenario. For the BMPs that are applied to land, this reflects a change in land use. The change may be caused by an actual conversion of land from agricultural to other uses, for instance, because of urban growth projected to occur between 2000 and 2010. It also may be caused by agricultural BMPs that cause land to shift from one agricultural land use category to another. For example, higher implementation rates of forest or grass buffers, wetlands restoration, carbon sequestration, and retirement of highly erodible land BMPs on high till land leaves less land available for the conservation tillage BMP. In some cases, the conservation tillage acreage is actually negative because the total number of acres in the tier scenario is lower than the number of acres in Progress 2000. Negative numbers for excess manure removal in Maryland are related to a projected decline in the number of animal units in Maryland from 2000 to 2010, as well as shifting animal types between 2000 and 2010 and variation in the nutrient content of the manure of different animal species, and shifting land uses to which the manure can be applied.

Exhibit 4: Tier 1 BMP Scenario: Delaware

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	2	-	-	0
Grass Buffers	565	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	139	42	0	-
Storm Water Management on New Dev.	1,137	425	-	-
Nutrient Management	0	-	-	60,791
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	713	1,747	72	21	-
Grass Buffers	312	762	-	-	-
Wetland Restoration	56	133	4	0	-
Retirement of Highly Erodible Land	0	0	0	-	-
Tree Planting	0	0	-	0	-
Farm Plans	0	0	0	0	-
Cover Crops	-8	8	-	-	-
Stream Protection w/ Fencing	-	-	-	0	-
Stream Protection w/o Fencing	-	-	-	0	-
Nutrient Management Plan Implementation	49,761	112,223	4,872	-	-
Grazing Land Protection	-	-	-	0	-
Animal Waste Management Systems	-	-	-	-	4
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	71,287
Conservation Tillage	721	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	175

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 1 BMP Scenario: District of Columbia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	1	-	-	0
Grass Buffers	144	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	138	0	148	-
Storm Water Management on New Dev.	0	0	-	-
Nutrient Management	0	-	-	0
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	0	0	0	0	-
Grass Buffers	0	0	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	0	0	0	-	-
Tree Planting	0	0	-	0	-
Farm Plans	0	0	0	0	-
Cover Crops	0	0	-	-	-
Stream Protection w/ Fencing	-	-	-	0	-
Stream Protection w/o Fencing	-	-	-	0	-
Nutrient Management Plan Implementation	0	0	0	-	-
Grazing Land Protection	-	-	-	0	-
Animal Waste Management Systems	-	-	-	-	0
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	0	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	0

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 1 BMP Scenario: Maryland

BMP — **Number of Acres**[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	77	-	-	5,223
Grass Buffers	20,042	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	5,621	2,680	74	-
Storm Water Management on New Dev.	52,875	23,912	-	-
Nutrient Management	0	-	-	0
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	4,999	7,682	2,048	3,106	-
Grass Buffers	2,387	5,316	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	460	655	261	-	-
Tree Planting	0	0	-	0	-
Farm Plans	28,908	15,730	20,901	-15,416	-
Cover Crops	-12,699	-19,262	-	-	-
Stream Protection w/ Fencing	-	-	-	14,468	-
Stream Protection w/o Fencing	-	-	-	2,965	-
Nutrient Management Plan Implementation	52,963	51,298	20,392	-	-
Grazing Land Protection	-	-	-	0	-
Animal Waste Management Systems	-	-	-	-	94
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	-4,229
Conservation Tillage	-53,587	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	18,959

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 1 BMP Scenario: New York

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	18	-	-	0
Grass Buffers	4,755	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	1,103	540	0	-
Storm Water Management on New Dev.	1,229	1,351	-	-
Nutrient Management	0	-	-	0
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	0	0	0	0	-
Grass Buffers	0	0	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	1,840	630	3,546	-	-
Tree Planting	0	0	-	0	-
Farm Plans	0	0	0	0	-
Cover Crops	0	0	-	-	-
Stream Protection w/ Fencing	-	-	-	0	-
Stream Protection w/o Fencing	-	-	-	0	-
Nutrient Management Plan Implementation	2,936	3,238	11,867	-	-
Grazing Land Protection	-	-	-	7,750	-
Animal Waste Management Systems	-	-	-	-	124
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	10,975	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	43,278

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 1 BMP Scenario: Pennsylvania

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	89	-	-	16,461
Grass Buffers	23,134	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	4,142	2,269	0	-
Storm Water Management on New Dev.	4,799	5,978	-	-
Nutrient Management	0	-	-	0
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	0	0	0	1,015	-
Grass Buffers	165	96	-	-	-
Wetland Restoration	149	80	174	0	-
Retirement of Highly Erodible Land	2,826	2,408	0	-	-
Tree Planting	0	0	-	0	-
Farm Plans	436,031	9,190	14,030	18,254	-
Cover Crops	0	0	-	-	-
Stream Protection w/ Fencing	-	-	-	6,862	-
Stream Protection w/o Fencing	-	-	-	746	-
Nutrient Management Plan Implementation	193,001	11,878	0	-	-
Grazing Land Protection	-	-	-	3,193	-
Animal Waste Management Systems	-	-	-	-	1,334
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	3,092
Conservation Tillage	58,426	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	165,242

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 1 BMP Scenario: Virginia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	170	-	-	0
Grass Buffers	44,440	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	8,595	3,807	104	-
Storm Water Management on New Dev.	31,661	27,603	-	-
Nutrient Management	22,022	-	-	0
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	1,074	2,092	969	0	-
Grass Buffers	566	820	-	-	-
Wetland Restoration	103	347	552	0	-
Retirement of Highly Erodible Land	3,073	7,436	20,871	-	-
Tree Planting	0	0	-	0	-
Farm Plans	37,760	110,244	206,110	298,315	-
Cover Crops	-16,833	-18,224	-	-	-
Stream Protection w/ Fencing	-	-	-	10,170	-
Stream Protection w/o Fencing	-	-	-	0	-
Nutrient Management Plan Implementation	29,986	72,414	107,210	-	-
Grazing Land Protection	-	-	-	106,729	-
Animal Waste Management Systems	-	-	-	-	211
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	587,611
Conservation Tillage	-38,965	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	35,943

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 1 BMP Scenario: West Virginia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	7	-	-	0
Grass Buffers	1,941	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	379	177	0	-
Storm Water Management on New Dev.	1,342	845	-	-
Nutrient Management	0	-	-	0
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	21	38	189	0	-
Grass Buffers	138	232	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	15	44	312	-	-
Tree Planting	0	0	-	0	-
Farm Plans	7,789	7,381	70,643	143,516	-
Cover Crops	-559	210	-	-	-
Stream Protection w/ Fencing	-	-	-	600	-
Stream Protection w/o Fencing	-	-	-	4	-
Nutrient Management Plan Implementation	718	2,084	13,478	-	-
Grazing Land Protection	-	-	-	57,194	-
Animal Waste Management Systems	-	-	-	-	37
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	-9,491	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	15,816

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	0

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: Delaware

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	59	-	-	56
Grass Buffers	508	-	-	-
Environmental Site Design / Low-Impact Dev.	431	161	-	-
Storm Water Retrofits	868	260	0	-
Storm Water Management on New Dev.	1,292	483	-	-
Nutrient Management	7,634	-	-	74,473
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	696	3,166	123	283	-
Grass Buffers	391	1,710	-	-	-
Wetland Restoration	30	159	4	0	-
Retirement of Highly Erodible Land	2,683	9,716	369	-	-
Tree Planting	0	0	-	0	-
Farm Plans	10,078	36,604	1,389	1,351	-
Cover Crops	13,413	48,800	-	-	-
Stream Protection w/ Fencing	-	-	-	168	-
Stream Protection w/o Fencing	-	-	-	95	-
Nutrient Management Plan Implementation	30,784	116,373	4,452	-	-
Grazing Land Protection	-	-	-	1,126	-
Animal Waste Management Systems	-	-	-	-	5
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	71,374
Conservation Tillage	4,871	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	524

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	318

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: District of Columbia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	15	-	-	14
Grass Buffers	130	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	863	0	928	-
Storm Water Management on New Dev.	0	0	-	-
Nutrient Management	6,908	-	-	298
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	0	0	0	0	-
Grass Buffers	0	0	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	0	0	0	-	-
Tree Planting	0	0	-	0	-
Farm Plans	0	0	0	0	-
Cover Crops	0	0	-	-	-
Stream Protection w/ Fencing	-	-	-	0	-
Stream Protection w/o Fencing	-	-	-	0	-
Nutrient Management Plan Implementation	0	0	0	-	-
Grazing Land Protection	-	-	-	0	-
Animal Waste Management Systems	-	-	-	-	0
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	0	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	0

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	19

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: Maryland

BMP — **Number of Acres**[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	2,057	-	-	7,571
Grass Buffers	17,824	-	-	-
Environmental Site Design / Low-Impact Dev.	17,760	8,097	-	-
Storm Water Retrofits	35,119	16,750	462	-
Storm Water Management on New Dev.	53,280	24,290	-	-
Nutrient Management	309,371	-	-	313,801
Urban Land Conversion	9,590	3,844	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	6,731	20,597	3,936	9,321	-
Grass Buffers	4,617	15,111	-	-	-
Wetland Restoration	1,202	3,108	639	0	-
Retirement of Highly Erodible Land	21,185	55,136	11,588	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-128,557	77,256	9,403	-18,062	-
Cover Crops	72,590	249,608	-	-	-
Stream Protection w/ Fencing	-	-	-	16,722	-
Stream Protection w/o Fencing	-	-	-	3,031	-
Nutrient Management Plan Implementation	-109,167	108,552	6,860	-	-
Grazing Land Protection	-	-	-	44,956	-
Animal Waste Management Systems	-	-	-	-	99
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	-4,712
Conservation Tillage	3,667	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	21,328

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	3,226

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: New York

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	494	-	-	476
Grass Buffers	4,280	-	-	-
Environmental Site Design / Low-Impact Dev.	465	512	-	-
Storm Water Retrofits	6,891	3,375	0	-
Storm Water Management on New Dev.	1,396	1,536	-	-
Nutrient Management	55,875	-	-	231,893
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	1,857	1,254	4,060	2,416	-
Grass Buffers	1,857	1,254	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	6,806	7,700	15,616	-	-
Tree Planting	0	0	-	0	-
Farm Plans	37,425	24,979	66,070	53,963	-
Cover Crops	49,901	33,306	-	-	-
Stream Protection w/ Fencing	-	-	-	7,521	-
Stream Protection w/o Fencing	-	-	-	4,262	-
Nutrient Management Plan Implementation	33,791	29,636	71,136	-	-
Grazing Land Protection	-	-	-	46,753	-
Animal Waste Management Systems	-	-	-	-	267
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	61,590	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	48,688

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	596

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: Pennsylvania

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	2,395	-	-	19,377
Grass Buffers	20,753	-	-	-
Environmental Site Design / Low-Impact Dev.	1,471	2,038	-	-
Storm Water Retrofits	25,871	14,182	0	-
Storm Water Management on New Dev.	4,413	6,113	-	-
Nutrient Management	209,320	-	-	608,303
Urban Land Conversion	1,811	906	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	11,677	16,545	21,614	8,298	-
Grass Buffers	11,738	16,660	-	-	-
Wetland Restoration	320	618	543	0	-
Retirement of Highly Erodible Land	34,190	66,994	79,070	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-209,479	307,677	527,958	200,582	-
Cover Crops	255,759	359,457	-	-	-
Stream Protection w/ Fencing	-	-	-	29,784	-
Stream Protection w/o Fencing	-	-	-	13,638	-
Nutrient Management Plan Implementation	-220,562	535,373	490,787	-	-
Grazing Land Protection	-	-	-	119,935	-
Animal Waste Management Systems	-	-	-	-	1,625
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	130,570
Conservation Tillage	269,892	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	185,897

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	1,346

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: Virginia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	4,587	-	-	4,417
Grass Buffers	39,755	-	-	-
Environmental Site Design / Low-Impact Dev.	10,395	9,768	-	-
Storm Water Retrofits	53,695	23,787	655	-
Storm Water Management on New Dev.	31,186	29,303	-	-
Nutrient Management	439,581	-	-	689,638
Urban Land Conversion	7,160	2,785	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	4,585	11,327	13,122	19,777	-
Grass Buffers	4,125	9,438	-	-	-
Wetland Restoration	276	894	1,255	0	-
Retirement of Highly Erodible Land	13,147	34,438	50,013	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-39,267	189,619	310,139	524,263	-
Cover Crops	58,905	170,646	-	-	-
Stream Protection w/ Fencing	-	-	-	60,332	-
Stream Protection w/o Fencing	-	-	-	28,535	-
Nutrient Management Plan Implementation	-8,866	154,443	268,710	-	-
Grazing Land Protection	-	-	-	388,064	-
Animal Waste Management Systems	-	-	-	-	267
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	677,907
Conservation Tillage	13,427	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	48,540

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	2,252

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 2 BMP Scenario: West Virginia

BMP **Number of Acres**[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	202	-	-	194
Grass Buffers	1,747	-	-	-
Environmental Site Design / Low-Impact Dev.	508	320	-	-
Storm Water Retrofits	2,371	1,107	0	-
Storm Water Management on New Dev.	1,525	960	-	-
Nutrient Management	19,780	-	-	79,091
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	202	446	2,892	6,637	-
Grass Buffers	234	596	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	942	2,542	10,506	-	-
Tree Planting	0	0	-	0	-
Farm Plans	1,304	9,688	58,958	140,496	-
Cover Crops	2,107	10,009	-	-	-
Stream Protection w/ Fencing	-	-	-	20,109	-
Stream Protection w/o Fencing	-	-	-	11,056	-
Nutrient Management Plan Implementation	2,238	9,494	42,784	-	-
Grazing Land Protection	-	-	-	123,147	-
Animal Waste Management Systems	-	-	-	-	71
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	-7,282	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	17,793

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	0	237

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: Delaware

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	172	-	-	169
Grass Buffers	395	-	-	-
Environmental Site Design / Low-Impact Dev.	862	322	-	-
Storm Water Retrofits	3,472	1,041	0	-
Storm Water Management on New Dev.	862	322	-	-
Nutrient Management	14,314	-	-	82,884
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	333	4,230	173	283	-
Grass Buffers	256	2,539	-	-	-
Wetland Restoration	5	184	4	0	-
Retirement of Highly Erodible Land	2,528	17,930	601	-	-
Tree Planting	0	0	-	0	-
Farm Plans	10,730	76,242	18,391	3,153	-
Cover Crops	11,463	81,666	-	-	-
Stream Protection w/ Fencing	-	-	-	839	-
Stream Protection w/o Fencing	-	-	-	70	-
Nutrient Management Plan Implementation	7,919	70,602	18,213	-	-
Grazing Land Protection	-	-	-	2,252	-
Animal Waste Management Systems	-	-	-	-	5
Yield Reserve	4,599	32,675	7,882	-	-
Carbon Sequestration	2,705	19,221	-	-	-
Excess Manure Removal	-	-	-	-	84,301
Conservation Tillage	-8,225	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	873

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	178	3,183

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: District of Columbia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	44	-	-	43
Grass Buffers	101	-	-	-
Environmental Site Design / Low-Impact Dev.	0	0	-	-
Storm Water Retrofits	3,454	0	3,715	-
Storm Water Management on New Dev.	0	0	-	-
Nutrient Management	12,952	-	-	515
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	0	0	0	0	-
Grass Buffers	0	0	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	0	0	0	-	-
Tree Planting	0	0	-	0	-
Farm Plans	0	0	0	0	-
Cover Crops	0	0	-	-	-
Stream Protection w/ Fencing	-	-	-	0	-
Stream Protection w/o Fencing	-	-	-	0	-
Nutrient Management Plan Implementation	0	0	0	-	-
Grazing Land Protection	-	-	-	0	-
Animal Waste Management Systems	-	-	-	-	0
Yield Reserve	0	0	0	-	-
Carbon Sequestration	0	0	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	0	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	0

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	32	188

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: Maryland

BMP **Number of Acres**[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	5,946	-	-	11,524
Grass Buffers	13,697	-	-	-
Environmental Site Design / Low-Impact Dev.	30,983	14,271	-	-
Storm Water Retrofits	140,422	67,002	1,846	-
Storm Water Management on New Dev.	30,983	14,271	-	-
Nutrient Management	573,056	-	-	629,729
Urban Land Conversion	19,181	7,689	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	4,163	30,526	5,833	9,572	-
Grass Buffers	3,571	24,562	-	-	-
Wetland Restoration	1,378	7,248	1,274	0	-
Retirement of Highly Erodible Land	19,011	102,747	18,278	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-281,734	26,207	143,400	-17,280	-
Cover Crops	40,681	436,543	-	-	-
Stream Protection w/ Fencing	-	-	-	27,628	-
Stream Protection w/o Fencing	-	-	-	2,183	-
Nutrient Management Plan Implementation	-301,971	-147,228	54,284	-	-
Grazing Land Protection	-	-	-	89,961	-
Animal Waste Management Systems	-	-	-	-	106
Yield Reserve	38,721	203,325	86,064	-	-
Carbon Sequestration	22,777	119,603	-	-	-
Excess Manure Removal	-	-	-	-	-2,758
Conservation Tillage	-48,788	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	23,698

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	3,187	32,258

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: New York

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	1,445	-	-	1,427
Grass Buffers	3,329	-	-	-
Environmental Site Design / Low-Impact Dev.	931	1,024	-	-
Storm Water Retrofits	27,565	13,499	0	-
Storm Water Management on New Dev.	931	1,024	-	-
Nutrient Management	104,765	-	-	448,885
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	1,592	3,076	8,120	3,623	-
Grass Buffers	1,857	3,588	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	5,107	18,883	24,688	-	-
Tree Planting	0	0	-	0	-
Farm Plans	39,750	76,230	165,386	125,068	-
Cover Crops	42,589	81,675	-	-	-
Stream Protection w/ Fencing	-	-	-	37,351	-
Stream Protection w/o Fencing	-	-	-	3,113	-
Nutrient Management Plan Implementation	12,429	42,458	84,339	-	-
Grazing Land Protection	-	-	-	85,190	-
Animal Waste Management Systems	-	-	-	-	467
Yield Reserve	9,560	18,582	40,871	-	-
Carbon Sequestration	10,021	19,218	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	87,226	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	54,098

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	1,109	5,960

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: Pennsylvania

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	6,984	-	-	24,244
Grass Buffers	16,088	-	-	-
Environmental Site Design / Low-Impact Dev.	2,272	3,623	-	-
Storm Water Retrofits	103,404	56,728	0	-
Storm Water Management on New Dev.	2,272	3,623	-	-
Nutrient Management	391,174	-	-	1,224,540
Urban Land Conversion	3,621	1,811	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	10,011	32,328	43,233	12,448	-
Grass Buffers	11,670	37,817	-	-	-
Wetland Restoration	284	1,398	894	0	-
Retirement of Highly Erodible Land	26,170	142,777	112,749	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-411,629	481,804	845,463	284,020	-
Cover Crops	217,537	698,013	-	-	-
Stream Protection w/ Fencing	-	-	-	120,271	-
Stream Protection w/o Fencing	-	-	-	9,954	-
Nutrient Management Plan Implementation	-464,123	482,723	531,400	-	-
Grazing Land Protection	-	-	-	234,634	-
Animal Waste Management Systems	-	-	-	-	2,031
Yield Reserve	66,818	211,831	227,743	-	-
Carbon Sequestration	51,185	164,238	-	-	-
Excess Manure Removal	-	-	-	-	220,368
Conservation Tillage	301,933	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	206,552

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	4,026	13,457

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: Virginia

BMP — Number of Acres[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	13,342	-	-	13,171
Grass Buffers	30,733	-	-	-
Environmental Site Design / Low-Impact Dev.	17,616	18,160	-	-
Storm Water Retrofits	214,670	95,141	2,619	-
Storm Water Management on New Dev.	17,616	18,160	-	-
Nutrient Management	824,828	-	-	1,331,151
Urban Land Conversion	14,319	5,571	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	3,460	18,842	25,290	28,143	-
Grass Buffers	3,818	18,783	-	-	-
Wetland Restoration	299	1,633	1,951	0	-
Retirement of Highly Erodible Land	11,004	65,910	76,856	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-127,599	202,200	515,800	814,169	-
Cover Crops	44,574	311,176	-	-	-
Stream Protection w/ Fencing	-	-	-	259,909	-
Stream Protection w/o Fencing	-	-	-	20,835	-
Nutrient Management Plan Implementation	-94,658	80,973	258,073	-	-
Grazing Land Protection	-	-	-	665,509	-
Animal Waste Management Systems	-	-	-	-	344
Yield Reserve	21,847	107,610	164,381	-	-
Carbon Sequestration	15,936	78,977	-	-	-
Excess Manure Removal	-	-	-	-	298,035
Conservation Tillage	-17,781	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	61,136

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	3,867	22,519

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

Exhibit 4: Tier 3 BMP Scenario: West Virginia

BMP — **Number of Acres**[1]

Urban	Pervious	Impervious	Ultra	Mixed Open
Forest Buffers	590	-	-	582
Grass Buffers	1,359	-	-	-
Environmental Site Design / Low-Impact Dev.	1,017	640	-	-
Storm Water Retrofits	9,483	4,429	0	-
Storm Water Management on New Dev.	1,017	640	-	-
Nutrient Management	37,087	-	-	152,548
Urban Land Conversion	0	0	-	-
Forest Conservation	0	0	-	-

Agriculture[2]	High Till	Low Till	Hay	Pasture	Manure
Forest Buffers	164	778	5,595	9,781	-
Grass Buffers	168	974	-	-	-
Wetland Restoration	0	0	0	0	-
Retirement of Highly Erodible Land	759	4,404	14,963	-	-
Tree Planting	0	0	-	0	-
Farm Plans	-4,759	8,002	57,659	138,115	-
Cover Crops	456	16,689	-	-	-
Stream Protection w/ Fencing	-	-	-	97,255	-
Stream Protection w/o Fencing	-	-	-	8,051	-
Nutrient Management Plan Implementation	-588	8,239	41,361	-	-
Grazing Land Protection	-	-	-	187,528	-
Animal Waste Management Systems	-	-	-	-	119
Yield Reserve	986	5,115	23,336	-	-
Carbon Sequestration	907	4,642	-	-	-
Excess Manure Removal	-	-	-	-	0
Conservation Tillage	-9,017	-	-	-	-

Forest	Forest Land
Forest Harvesting Practices (Erosion Control)	19,770

Onsite Wastewater Management Systems	Existing Systems	New Systems
Denitrification w/ Pumping[3]	372	2,365

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

When these reductions in acres are multiplied by the estimated annual practice costs, the result will be a cost savings. For instance, cover crop costs are incurred every year, and if the land is converted out of agricultural production, the cover crop costs will no longer be incurred. However, Exhibit 4 does not report net reductions in implementation for practices for which the major portion of the annual cost is a sunk cost (e.g., forest buffers), because no cost savings will occur from the land conversion or changes in BMP application.

The following sections document the derivation of unit costs for the practices contained in Exhibit 4. The unit costs are annual implementation costs in constant 2001 dollars. The measurement units match the BMP quantities, which are generally expressed in acres affected each year. Therefore, most of the unit costs represent an average or typical cost per acre per year ($/ac/yr). The per-acre format is necessary to estimate annual costs for the different control scenarios from the Chesapeake Bay Program's watershed model. Annual costs include annualized capital expenditures (e.g., for infrastructure) and annual operating and maintenance costs.

2.2.1 Agriculture

Cost-sharing is commonly used to encourage implementation of agricultural BMPs. These programs provide four types of financial assistance: a cost offset for upfront BMP implementation expenses (**Exhibit 5**), annual land rent (**Exhibit 6**), annual maintenance payments, and one-time incentive payments.[3] The Chesapeake Bay Program used the upfront cost shares to offset initial BMP implementation costs, and assumed that the annual rental revenue completely offsets any net revenue losses the farmer might incur because of changes in production practices or foregone production. Thus, where the actual net revenue loss is less than the annual rental payment, costs to the farmer are overestimated. Annual maintenance and one-time incentive payments are subtracted from farmer costs, but other costs of maintaining BMPs (O&M) are generally not eligible for cost-share.[4]

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[3] Conservation Reserve Enhancement Programs in DE, MD, PA, VA, and WV, and the draft Program for the Susquehanna watershed in NY, provide annual maintenance payments of $5/ac/yr for a 10- to 15-year contract for forest and grass riparian buffers, wetland restoration, retirement of highly erodible land, tree planting, and farm plans (soil conservation and water quality plans). In Maryland, the CREP program also offers a one-time incentive payment of $100/ac for forest and grass riparian buffers, wetland restoration, and retirement of highly erodible land. In Virginia, the CREP program offers a one-time incentive payment of $50 or $75/ac (for 10- or 15-year contracts, respectively) for forest and grass riparian buffers, wetland restoration, retirement of highly erodible land, tree planting, and farm plans (soil conservation and water quality plans). The cost estimates reflect an average incentive payment of $62.50/ac (i.e., the average of $50/ac and $75/ac) in Virginia.

[4] Farms that implement BMPs as a result of regulations imposed by the CAFO Rule or CZARA are eligible for funding from federal and state cost sharing programs.

Exhibit 5: Capital Cost Funding for Agricultural BMPs from Known State and Federal Programs[1]

Practice	DE	MD	NY	PA	VA	WV
Forest Buffers	87.5%	87.5%	87.5%	100%	75%	75%
Grass Buffers	87.5%	87.5%	87.5%	100%	75%	75%
Wetland Restoration	87.5%	87.5%	87.5%	100%	75%	75%
Retire Erodible Land	87.5%	87.5%	87.5%	100%	75%	75%
Tree Planting	87.5%	87.5%	75%	75%	75%	75%
Nutrient Management Plan	$10/ac/ 3yrs[2]	$6/ac/ 3yrs[2]	87.5%	80%	$3/ac/yr[2]	75%
Cover Crops	75%	$20/ac/yr[2]	87.5%	$15/ac/yr[2]	75%	75%
Stream Protection w/ Fence	75%	87.5%	87.5%	100%	75%	75%
Stream Protection w/o Fence	75%	87.5%	87.5%	80%	75%	75%
Grazing Land Protection	75%	87.5%	87.5%	80%	75%	75%
Animal Waste Management	75%	87.5%	87.5%	80%	75%	75%

Sources: DDA (2002a), MDA (2000), NY Soil and Water Conservation Committee (no date), PA DEP (1998, 2001), USDA-FSA (1997a, 1997b, 1999a, 1999b, 2000a, 2000b, 2002a, 2002b), USDA-NRCS (no date, 1998, 2001a, 2001b, 2001c, 2001d, 2001e, 2001f), VA DCR (2001), personal communication with Gary Smith (PA NRCS, April 2002), Cedric Karper (PA DEP, May 2002), John Long (MD NRCS, May 2002), Mark Waggoner (MD NRCS, May 2002), Michelle Esch (MACS, May 2002), Lester Stillson (DE NRCS, April 2002), Ken Carter (VA NRCS, May 2002), Dana Bayless (VA Division of Conservation and Recreation, April 2002), Teresa Koon (WV Soil Conservation Agency, May 2002), Rick Heaslip (WV NRCS, April 2002), and Emily Dodd (NY State Department of Agriculture and Markets, May 2002 and November 2002).

1. Percentage rates reflect a percentage of actual installation (capital) costs.
2. Certain programs in some states pay a fixed rate rather than a percentage of costs: in DE (two programs pay $5/ac each for a 3-year nutrient management plan); in MD (MACS pays $6/ac for a 3-year nutrient management plan, and $20/ac/yr for cover crops); in PA (PA EQIP pays $15/ac/yr for cover crops); and in VA (VACS pays $3/ac/yr for nutrient management plans).

Exhibit 6: Annual Funding from Identified Programs for Land Rental Associated with Agricultural BMPs, as a Percent of USDA Dryland Rental Rate for County[1]

Practice	DE	MD	NY[2]	PA	VA	WV[2]
Forest Buffers	250%[3]	190%	145%	220%	240%[4]	120%
Grass Buffers	170%[5]	170%	145%	220%	240%[4]	120%
Wetland Restoration[6]	125%[5]	125%	145%	175%	195%[4]	75%
Retire Erodible Land	100%	150%	145%	175%	220%[4]	100%
Tree Planting	230%[3]	100%	145%	100%	100%	100%

Sources: USDA-NRCS (no date); USDA-FSA (2002b, 2002c, 2000a, 2000b, 1999a, 1999b, 1997b); personal communication with Emily Dodd (NY State Department of Agriculture and Markets, November 2002).

1. Reflects rental payments from the USDA CRP (or WRP, for wetland restoration) and state CREP programs. Rental payments are made only for BMPs that result in taking land out of agricultural production. Rates shown do not include annual maintenance or one-time incentive payments. Rental payments are also made for certain practices associated with farm plans (see Section 2.2.1.6).
2. NY CREP program for the Bay watershed is pending USDA approval; percentages shown are from NY state draft program documents.
3. The annual rental payment cannot exceed $150 per acre.
4. The annual rental payment cannot exceed $100 per acre.
5. The annual rental payment cannot exceed $110 per acre.
6. USDA WRP rental payment can be 0%, 75% or 100% of dryland rental rate, depending on length of contract; the analysis uses 75%, which corresponds to a 30-year contract.

The funding percentages listed in Exhibits 5 and 6 reflect the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) in all states, and Environmental Quality Incentive Program (EQIP) cost shares for DE, MD, PA, VA, and WV.[5] In addition, the exhibits include cost sharing from the Maryland Agricultural Water Quality Cost-Share Program (MACS) and Wildlife Habitat Incentives Program (WHIP) in Maryland; the Virginia Agricultural BMP Cost-Share Program (VACS) in Virginia; the Delaware Department of Agriculture Nutrient Management Cost Share Program in Delaware; the NY Agricultural Nonpoint Source Abatement and Control Program (ANPSACP); the Pennsylvania Department of Environmental Protection (DEP) Chesapeake Bay Financial Assistance Funding Program and Streambank Fencing Program in Pennsylvania; and the West Virginia Potomac Headwaters Water Quality Project (implemented under Public Law 534) in West Virginia.

The funding levels shown indicate the potential cost share if all programs are fully funded at current rates. In most cases, farmers are eligible for funding from more than one program (e.g., installation costs for riparian forest buffers in Maryland can be cost-shared under EQIP at 75%, CRP/CREP at 87.5%, MACS at 87.5%, and WHIP at 75%). Although most programs require

[5] New York is developing a CREP program for portions of the state that will include the Chesapeake Bay watershed. Information cited here is based on draft information provided by Emily Dodd, NY State Soil and Water Conservation Committee, November 2002, and information in USDA-FSA (2002c). Because the agreement has not been finalized, the information used in the analysis is subject to change.

landowners to contribute a portion of installation costs, certain programs, such as the Pennsylvania DEP Stream Bank Fencing Program, provide 100% funding for installation of selected BMPs.

Exhibit 5 does not reflect changes to the Wetlands Reserve Program (WRP), CRP, or EQIP in the 2002 Farm Bill, including an increase in the possible EQIP cost-share percentage for limited-resource farmers to 90% (from 75%) for eligible BMPs. Although relatively few small farmers meet the definition of a limited-resource farmer, they are likely to be the ones least able to pay additional BMP costs. Also, Virginia, Maryland, and possibly other states have additional rewards for farmers implementing BMPs in the form of tax credits. The estimates below do not incorporate tax credits, which means that some estimates will overstate farmer costs.

The annual cost of agricultural BMPs reflects amortized capital costs plus annual O&M payments. Capital costs are commonly paid upfront when a BMP is implemented (i.e., the farmer does not take out a loan). However, to estimate an annual cost for evaluating financial impacts, the Chesapeake Bay Program amortized capital costs at 5% (instead of assuming no interest cost) to represent an opportunity cost (since farmers typically implement BMPs with profits from a good year, these funds cannot then be saved for a future year). Capital costs are amortized over the typical contract period provided by the cost share programs for each BMP. However, if contract period does not apply (e.g., BMPs not cost shared through the CRP or CREP programs), the annualization period is the estimated useful life of the practice.

Cost estimates for agricultural BMPs are reported in the original dollar year reported in the source studies (where known), as well as in constant 2001 dollars [updated using the USDA Economic Research Service (ERS) index of prices paid by farmers (USDA-ERS, 2001)]; averages reflect 2001 dollars.

2.2.1.1 Forest Buffers

In the Watershed Model, forest buffers are 100-foot-wide strips of forest along riparian corridors in both agricultural and urban land. Implementation costs consist of planting tree seedlings in the first year and relatively intensive maintenance in the years immediately following implementation (replacement planting, herbicides or mowing to reduce competition, and plastic tubes to shelter seedlings from herbivory). Costs can also include reductions in net revenue and out-of-pocket expenses to implement the BMP. The variables that drive cost estimates for forest buffers are the costs of seedlings and shelters, and the amount of intensive maintenance in the first years.

The amount of intensive maintenance required on forest buffers is directly related to the degree of establishment desired and, therefore, the reduction efficiency of the practice. However, information on the level of maintenance required for various reduction efficiencies is not available. Therefore, the estimates below reflect the assumption that forest buffers are mowed in the early years to reduce competition, and shelters to reduce herbivory are used on 50% of trees. Four sources (Palone and Todd, 1998, USDA, 1999, Hairston-Strang, 2002, and MDA, 2002b) contain comprehensive estimates of the cost of installation and maintenance, and two additional sources provide less complete information (MD DNR et al., 1996, and VA SNR, 2000). The final cost estimate is based on the first four sources.[6]

Exhibit 7 shows cost estimates for individual components of forest buffer installation and maintenance (costs shown reflect constant 2001 dollars, adjusted from the original sources where necessary), and the average cost for each component across sources, where applicable. The costs for the latter two sources (Hairston-Strang, 2002 and MDA, 2002b) are somewhat lower than the costs for the first two sources. One reason for the difference may be that the costs shown for the other two sources are based on an assumption that tree shelters are used on 50% of the trees planted, whereas the costs from the latter two sources are based on surveys of actual implementation costs in Maryland. The average capital cost for installation among the four sources is $1,284 per acre.

Exhibit 7: Cost Estimates ($/acre) for Riparian Forest Buffers[1]

<table>
<tr><th>Component</th><th>Palone & Todd (1998)</th><th>USDA (1999)</th><th>Hairston-Strang (2002)[3]</th><th>MDA (2002b)[4]</th><th>Average Cost</th></tr>
<tr><td>Site preparation</td><td>13</td><td>nd</td><td rowspan="4">1,000</td><td rowspan="4">812</td><td rowspan="4">1,284</td></tr>
<tr><td>Planting and replacement planting</td><td>616</td><td>613</td></tr>
<tr><td>Tree shelters[2]</td><td>1,511</td><td>528</td></tr>
<tr><td>Initial grass buffer for immediate soil protection</td><td>nd</td><td>42</td></tr>
<tr><td>Mowing ($/time)</td><td>13</td><td>8</td><td>30</td><td>nd</td><td>17</td></tr>
<tr><td>Herbicide ($/time)</td><td>60</td><td>nd</td><td>100</td><td>nd</td><td>80</td></tr>
</table>

nd = No data. Costs are one-time installation costs unless otherwise noted.

1. All costs shown are in constant 2001 dollars, updated from original study estimates using the USDA/ERS index for prices paid by farmers (USDA-ERS, 2001), and reflect per-acre costs.
2. Costs shown for tree shelters reflect installation of shelters on 50% of trees planted.
3. Costs shown are an average of a representative sample of actual costs for installing forest buffers in different regions in Maryland.
4. Costs shown are average practice costs in Maryland for 2001-2002 according to the Maryland Agricultural Water Quality Cost-Share (MACS) program.

Hairston-Strang (2002) indicates that a representative maintenance schedule for the first few years of establishment would be to mow three times per year for three years, and to spray herbicides for weed control once. Based on this, the Chesapeake Bay Program calculated maintenance costs as equal to nine times the average mowing cost ($153 per acre total) plus the average cost for spraying herbicides ($80 per acre total), or $233 per acre. The overall cost for installation and maintenance, therefore, is $1,517 per acre.

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[6] Of the less documented sources, MD DNR et al. (1996) indicates a capital cost of $480/ac/yr ($534 in 2001 dollars) for planting and establishment, which is $60/ac/yr annualized at 5% over 12 years. VA SNR (2000) indicates a cost of $230/ac/yr for the practice ($232 in 2001 dollars), but does not specify service life, interest rate, or what cost components are included.

The potential service life for a forest buffer may be on the order of 75 years (MD DNR et al., 1996). However, as stated above, to estimate financial impacts, capital costs are annualized over contract periods. (As a result, impacts in future years will be lower by the amount of the capital cost if the service life of the practice exceeds the contract period). CREP offers 10- and 15-year contracts for forest buffers, and most landowners choose 15-year contracts. The historical practices of the Conservation Reserve Program suggest that farmers will likely be able to extend contracts for 10 additional years. Therefore, capital costs are annualized over 25 years.

Annualizing the total installation and early maintenance costs of $1,517 at 5% over 25 years gives an annualized capital cost of $108 per acre, of which 85% is installation cost. Cost-sharing is available for the installation costs at rates ranging from 75% to 100%. In addition, CREP programs offer annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Maryland and Virginia, and Maryland also offers an additional sign-up bonus. Thus, the net farmer costs for forest buffers range from -$8/ac/yr (i.e., a net revenue gain) to $34/ac/yr.

In addition to the implementation cost, there is an opportunity cost associated with taking land out of production. In some cases, land bordering streams or rivers is more productive than the farm or field average because of higher soil fertility associated with the flood plain, but in many cases riparian borders are considered marginal land because of greater erosion, steep slopes, poor drainage, periodic flooding, and low soil fertility (Palone and Todd, 1998; USDA, 1999). As stated above, the land rental payment from CREP likely offsets any net revenue losses from changes in land use resulting from this practice.

2.2.1.2 Grass Buffers

In the Watershed Model, grass buffers are 100-foot-wide strips of grass along riparian corridors. Establishment costs include purchase of seed, fertilizer and lime, initial planting, and mowing to maintain the practice and to prevent grasses from going to seed, in addition to opportunity costs from taking land out of production. Maintenance costs include mowing. An important consideration in calculating a cost for grass buffers is whether warm-season grasses (WSG) or cool-season grasses (CSG) are used. WSG seed is more expensive, but the grasses grow better in drought and provide better wildlife habitat. CSG seed is cheaper, sod establishment is faster, and sediment load reduction is generally greater because the plants are more active in spring and fall (Nakao et al., 1999). Data on the relative use of cool- and warm-season grasses are not available, so costs are based on equal use of cool- and warm-season grasses.

Several sources provide cost estimates for grass buffers. The Chesapeake Bay Program used estimates from Nakao et al. (1999) and Yeh and Sohngen (1999) because they itemize costs for seed, fertilizer and lime, and planting costs, and because they distinguish the costs of warm season and cool season grasses.[7] **Exhibit 8** shows the resulting cost estimates for each component of the BMP.

[7] Data from the MACS program, indicating a maximum cost-share amount of $200/acre for CSG buffers and $400/acre for WSG buffers, are not included in the estimates because these represent maximum payment amounts rather than practice costs. The higher maximum payments likely reflect the potential for site preparation costs to be much greater than average.

Exhibit 8: Grass Buffer BMP Costs ($/acre)[1]

Component	Estimated Cost (CSG)[2]	Estimated Cost (WSG)[3]
Seed	$21	$120[4]
Fertilizer and lime	$38	$38
Labor and equipment[5]	$23	$23
Total cost	$82	$181

CSG = Cool-season grass
WSG = Warm-season grass

1. All costs shown are in 2001 dollars, updated from current dollars using the USDA/ERS index for prices paid by farmers (USDA-ERS, 2001), and reflect costs for installation.
2. From Nakao et al. (1999).
3. From Sohngen and Yeh (1999).
4. Based on average seed costs for switchgrass ($40/ac), big bluestem ($150/ac), and indiangrass ($160/ac).
5. Based on costs for no-till planting.

The average cost for the installation of grass buffers, based on 50% implementation of CSG and 50% implementation of WSG buffers, is $132/acre. Annualized at 5% over 10 years (the minimum term of a CRP/CREP contract), installation costs are $17/ac/yr.

Possible O&M costs for grass buffers consist of mowing. Four sources for mowing costs are reflected in the estimate for this practice: USDA, 1999 ($8/ac/time in 2001 dollars), Palone and Todd, 1998 ($13/ac/time in 2001 dollars), Hairston-Strang, 2002 ($30/ac/time), and Nakao et al., 1999 ($25/ac/time in 2001 dollars). The average cost for mowing from these sources is $19/ac/time. If mowing is necessary to maintain buffer strips, then it would need to happen two to three times per year (Hairston-Strang, 2002; Nakao et al., 1999). In locations where topography allows hay harvesting, revenue from haying could offset mowing costs. For instance, Nakao et al. (1999) found that net revenues from haying filter strips in Ohio (i.e., revenue from hay less costs of cutting and baling) averaged $91 per acre.+

Some cost-share programs do not permit grasses to be harvested for hay. However, this may refer to the regular harvest of grasses down to stubble, which would reduce the capacity of a grass buffer to trap nutrients and sediment as it is designed to do. If grasses must be mowed, then the clippings should be removed from the buffer so that they do not enter water bodies and contribute nutrients. Even if the grass is mowed too high to be sold for hay, it could be used on the farm as bedding, feed, mulch or fertilizer. In addition, some native warm-season grasses may not need to be mowed. A mowing cost is not currently included in the cost estimate. Although costs for some areas may be higher if mowing is necessary and the cost is not offset by using the clippings, costs for some areas may be lower than the $17/ac/yr estimate because it is based on average seed costs for three different warm-season grasses; if switchgrass is used (by far the cheapest of the three), actual costs could be substantially lower. The installation cost accounts for 100% of the total annual cost of $17/ac/yr and, therefore, installation cost-sharing applies to 100% of the total cost.

The annual rental payment for this BMP ranges from 120% to 240% of the dryland rental rate across states. As stated above, this likely offsets any net revenue losses from changes in land use and, therefore, the cost of the BMP is out-of-pocket expenses less cost-share funding for installation of the buffer. Cost-sharing ranges from 75% to 100% of implementation costs (see Exhibit 5), and CREP programs also provide annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Maryland and Virginia. Thus, net unit costs range from -$13/ac/yr (i.e., a net cost savings) to -$1/ac/yr.

2.2.1.3 Wetland Restoration

Wetland restoration reverses wetland reclamation, or the draining of wetlands so they can be planted. Significant earth moving may be required (e.g. to plug or fill drainage ditches that were dug in the process of reclamation). O&M costs include inspecting embankments and structures for damage or erosion, and management of unwanted vegetation (USDA-NRCS, 1998).

Three sources contain cost estimates for this practice. The USDA Farm Service Agency's Practice Summaries for Active CREP Contracts for states with CREP programs (USDA-FSA, 2002a) reports wetland restoration cost-shares for Delaware (2001-2002), Maryland (1998-2002), Pennsylvania (2001-2002), and Virginia (2001-2002). The average cost-share amount per acre for these states is $915 (in 2001 dollars), and represents cost-share for installation but not O&M costs. Assuming that average cost-share is 75% and O&M costs are 3% of total initial capital costs (USDA-SCS, 1980 in NCSU, 1982 reports O&M for permanent vegetative cover on critical areas, a comparable BMP, is 3% of initial capital costs), the initial capital costs are $1,221/acre and annual O&M costs are $37/acre. Under the Wetlands Reserve Program, contract terms range from 30 years to indefinite. Annualizing the capital cost at 5% over 30 years and adding O&M costs results in an annual cost of $116/ac/yr. Sixty-eight percent of this cost is annualized capital (installation) cost and therefore eligible for cost-share; the remainder is O&M, which is not eligible for cost-share.

Of the other two sources identified, Wetland Science Institute (2000) provides costs for site preparation and materials and planting costs for putting in oak seedlings or seeds, but does not include costs for putting in other species or O&M costs. Average costs for site preparation and materials and planting are $123 per acre ($124 in 2001 dollars), which is very close to the estimates based on actual wetland restoration projects cost-shared by CREP as reported above. The second source (EPA, 1997a) reports average costs for constructed wetlands for controlling urban runoff at between $749 and $20,000 per acre (in current dollars); however, as this source does not elaborate as to what costs are included, how costs are calculated, or how costs in agricultural areas might differ from costs in urban areas, these estimates are not used.

Funding for wetland restoration ranges from 75% to 100% of installation costs (see Exhibit 5), and CREP programs also provide annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Maryland and Virginia. Thus, net farmer costs range from $32 to $52/ac/yr. Annual rental rates range from 75% to 195% of the USDA dryland rental rate within a county. As stated above, this annual revenue likely offsets any net revenue losses attributable to changes in land use.

2.2.1.4 Retirement of Highly Erodible Land (HEL)

In the Watershed Model, this practice consists of converting agricultural land to the mixed open land use category. Although either grass or trees may be used as a cover, in the Watershed Model this practice is modeled as a conversion to mixed open land use, and the load from mixed open land use is closer to the load from hayland than the load from forest. Thus, the cost estimates used reflect the costs of establishing grass cover. Additional costs accrue as a result of foregone net revenues from crop plantings.

Several sources contain cost estimates ranging from $9/ac/yr to $157/ac/yr (in 2001 dollars) for permanent vegetative cover on critical areas (VA SNR, 2000; MD DNR, 1996; VA DEQ, 1993; EPA, 1997a; and Camacho, 1992). The estimates from these sources reflect different assumptions about what type of cover is used, service life, O&M costs, and net revenue impacts, among others. Documentation on most of the sources is quite sparse, so there is little basis for comparison.

This practice could entail planting of grass or forest cover, and is therefore similar to the riparian grass and forest buffer BMPs. To reflect the way this practice is modeled in the Watershed Model, the establishment cost reflects the cost of grass buffers, $17/ac/yr. The implementation cost share, which ranges from 75% to 100% across states, annual maintenance payments of $5/ac/yr from CREP programs, and one-time incentive payments available in Maryland and Virginia, reduce net implementation costs to - $13/ac/yr to - $1/ac/yr. Furthermore, as stated above, annual revenues per acre that equal 100% to 220% of the USDA dryland rental rate across states (Exhibit 6) likely offset any revenue loss associated with land retirement.

2.2.1.5 Tree Planting

In the Watershed Model, the tree planting BMP occurs in any area except along a river or stream, and is modeled as a land use conversion from agricultural or urban land to forest. Because this BMP is very similar to forest buffers, the unit cost of $108/ac/yr for forest buffers applies. As with forest buffers, the cost includes a combination of mowing and herbicide sprays to reduce competition in the initial years.

The cost-share for implementation ranges from 75% to 87.5% across states, and CREP programs offer annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Virginia. Thus, net farmer costs range from $23 to $34/ac/yr. The federal CRP program and state CREP programs offer annual payments ranging from 100% to 230% of the USDA dryland rental rate (Exhibit 6) to offset net income losses from land planted to trees, and this rental payment likely offsets any net revenue losses.

2.2.1.6 Farm Plans/Soil Conservation and Water Quality Plans

In the Watershed Model, farm plans represent comprehensive management plans according to which structural or management practices are implemented to bring total soil loss to an acceptable level (the specific level depends on local conditions). Specific practices that may be implemented include contour farming, strip cropping, terrace systems, diversions, and grassed waterways. Farm plans also frequently include conservation tillage, nutrient management plans, cover crops, and other practices that are included as separate BMPs in the Watershed Model.

Several sources provide cost estimates for individual practices that may be implemented in accordance with a farm plan. However, estimating a single per-acre cost is more difficult than for other BMPs because only some of these practices may be used depending on site-specific conditions. The costs in the cost analysis are based on estimates from Camacho (1992), who obtained 14 representative farm plans from state contacts in Pennsylvania, Maryland, and Virginia. These plans include different application rates for the individual practices, and represent plans for different regions in the watershed. Camacho estimated the median cost per acre for the development of plans as well as the practices implemented under the plans, but the costs in his report include some costs from practices included separately in the Watershed Model (such as cover crops and conservation tillage).

To avoid double-counting costs for BMPs that are included separately in the Watershed Model, the Chesapeake Bay Program calculated an average cost of farm plans using Camacho's data, subtracting the costs of these "duplicated" BMPs. In addition, it differentiated costs for development and implementation of farm plans on hay and pasture land from the costs for plans on cropland, because some practices associated with farm plans would be applied only to one type of land and not the other. For example, strip-cropping on cropland involves alternating strips of row or grain crops with strips of closer growing crops; the closer growing strips reduce erosion by slowing runoff and capturing soil particles. This practice would not be used in hay production or pasture land because the sod remains intact. After eliminating the "duplicated" BMPs from the representative farm plans in Camacho (1992), the practices for cropland include strip-cropping, contour strip-cropping, contour farming, terraces, diversions, grassed waterways, and crop rotation. For hay and pasture land, the applicable practices are diversions, grassed waterways, terraces, and contour planting.

Costs for the practices implemented according to farm plans may differ depending on topography, since more intensive management may be needed to control soil erosion on sloping or mountainous land than on coastal plain. However, the estimates based on Camacho (1992) for practices associated with farm plans (excluding the costs of the duplicate BMPs) are not significantly different between the two topographic regions ($19/ac/yr on coastal land versus $20/ac/yr in sloping regions, in 2001 dollars). The average cost of the practices associated with farm plans is $19/ac/yr for plans on crop land, and $15/ac/yr on hay and pasture land (in 2001 dollars). These estimates include planning and technical assistance (for the practices associated with the farm plan, although not for the farm plan itself), installation costs, and annual O&M, with installation costs annualized at 10% over the life of the practice (ranging from 5 to 10 years for the individual practices). The Chesapeake Bay Program re-annualized these costs at a 5% rate over 10 years by backing out the original capital cost (assuming O&M costs equal 5% of the initial capital cost that reflects annualizing at 10% over 10 years). The adjusted estimates are $16/ac/yr for farm plans on cropland and $13/ac/yr on hay and pasture.

These costs do not include the cost of the plan itself. Based on costs for designing nutrient management plans from USDA (1999), the estimated cost for a farm plan is $5 per acre, and the estimated useful life is 10 years (MD DNR et al., 1996). Adding in the resulting annual cost of

$0.50 per acre results in an estimated cost of the plan and the practices associated with it of $17/ac/yr on cropland and $13/ac/yr on hay and pasture (the costs for hay and pasture do not appear to change because of rounding). Seventy percent of the costs for the BMP on cropland, and 69% for hay and pasture land, are annualized capital and therefore eligible for cost-share. The annualized capital portion of the cost does not include the cost of the plan itself, since cost-sharing programs generally do not pay for the plan itself but only for the practices associated with it.

Funding for installation of practices associated with farm plans ranges from 75% to 100% over the states, which applies to the 70% of costs that are annualized capital (69% for farm plans on hay and pasture land). Annual maintenance payments of $5/ac/yr are available from CREP programs for certain practices (such as grassed waterways) associated with farm plans. One-time incentive payments for the installation of certain practices are also available in Virginia. However, the Chesapeake Bay Program did not incorporate maintenance or incentive payments because data are insufficient to identify the proportion of land on which the eligible practices would be implemented. Thus, net farmer costs range from $5 to $8/ac/yr for farm plans on crop land and from $4 to $6/ac/yr for farm plans on hay and pasture. Annual rental payments from CRP and CREP equal to 100%–200% of USDA dryland rental rates by county likely offset any net revenue losses resulting from land taken out of production or changes in production activity. However, due to a lack of data on how much land is taken out of production as a result of the practices associated with farm plans, cost-share totals do not include these rental payments.

2.2.1.7 Cover Crops

Cover crops are grasses and legumes planted on cropland in the fall after the main crop is harvested, and killed in the spring before the main crop is planted. In addition to building organic matter and improving nutrient uptake, they reduce soil erosion in late fall, winter, and early spring.

The major costs are purchasing cover crop seed and machinery and labor for planting. Although some estimates of costs include the costs of tillage or herbicide in the spring to kill the cover crop, these costs are not included because they are necessary regardless of whether a cover crop is used (except when spring weather conditions or special management requirements necessitate a separate round of tillage or herbicide for the cover crop). Benefits come from sediment erosion protection and holding nutrients not utilized during the growing season.

Several sources (Mannering et al., 1985; Roberts et al., 1998; VA SNR, 2000; MD DNR et al., 1996; Camacho, 1992; Lichtenberg et al., 1994) report estimates of cover crop costs ranging from $10/ac/yr to $37/ac/yr in current dollars ($12/ac/yr to $49/ac/yr in 2001 dollars). Because of variations in these estimates and sometimes incomplete documentation regarding what costs are included, costs are based on another source (personal communication with Ken Staver, Wye Research and Education Center, Queenstown, MD, May 2002). For a rye cover in a no-till system, Staver estimates seed costs at $12/ac and planting costs at $15/ac.

The resulting cost estimate of $27/ac/yr does not reflect possibly greater costs due to the possibility of an additional herbicide application in the spring, nor does it reflect increased risk (for instance, in a wet spring the need to turn in the cover crop may delay spring planting). However, it also does not reflect potential cost offsets due to improved yields. Yield increases have the potential to make the cover crop pay for itself or generate net revenue. For example, one group of researchers observed an average net revenue increase of $16/ac/yr in no-till corn using vetch, clover, wheat, and pea cover crops because the cover crops increased nutrient uptake and the marginal productivity of nitrogen (Lichtenberg et al., 1994).

Cost-sharing for cover crops in some programs is provided at a fixed dollar rate; other programs pay a percentage of incurred costs. Expressed as a percentage of the estimated cost of $27/ac/yr, rates range from 56% to 87.5%. Thus, the net farmer cost ranges from $3 to $12/ac/yr.

2.2.1.8a Streambank Protection with Fencing

Streambank protection consists of fencing to keep animals out of streams, alternative water and shade sources in pastures, and practices at stream crossings to reduce soil erosion from hooves and reduce the amount of time animals spend in the water (e.g., culverts or concrete fords at stream crossings). The Watershed Model reports linear fence miles for stream protection as well as total acreage protected. Ideally, the cost analysis would incorporate the linear fencing data to calculate the cost of fencing and use protected acreage data to estimate the costs of other practices associated with streambank protection. Fence miles is ideal for fence costs, but uninformative for alternative water source costs.

Linear fence cost estimates from U.S. EPA (1997a) range from $2,330 to $2,677 per mile (or $2,816 to $3,235 in 2001 dollars, which is $365 to $420 per mile when annualized at 5% over 10 years). Most of these are for permanent fencing (presumably barbed wire) in the West and Midwest; one source notes that less expensive electric fencing may be sufficient for smaller, more intensively managed pastures in the East, but no estimates of these costs are available. The average of the costs identified ($395/mile) may thus overestimate costs if farmers use less expensive fencing.

Two sources provide cost estimates for the suite of practices associated with the streambank protection with fencing BMP. USDA-ASCS (1990, cited in EPA, 1997a) reports average costs ranging from $14/ac/yr in the Pacific region ($18/ac/yr in 2001 dollars) to $76/ac/yr in the Southeast region ($97/ac/yr in 2001 dollars) for stream protection practices that may include, depending on the site, filter strips along streams, channel vegetation, fencing, pipelines, streambank and shoreline protection, field borders, tree planting, troughs or tanks for water in pastures, and stock trails or walkways at stream crossings.[8] MD DNR et al. (1996) reports a cost of $100/ac/yr ($111/ac/yr in 2001 dollars) for a suite of practices called "streambank protection with fencing," based on records from the Maryland Agricultural Water Quality Cost-Share (MACS) Program. Averaging this estimate with the estimate for the Southeast region from

[8] Because this data source includes the costs of filter strips on a proportion of acres, but in this analysis filter strip costs are accounted for separately, using the costs from this source may result in double-counting some costs for acres in the Watershed Model to which both the forest buffer BMP and the streambank protection BMP are applied.

USDA-ASCS (1990) results in a cost of $104/ac/yr (2001 dollars) for streambank protection with fencing.

The cost-share for streambank with fencing ranges from 75% to 100%. Of the two sources for costs of streambank protection with fencing, neither breaks out capital from O&M costs. Assuming that capital costs are annualized at 5% over10 years and O&M costs are 5% of the initial capital costs, capital costs represent 72% of the total annual cost. Thus, the cost-share rates apply to 72% of the annual cost estimate. The net farmer cost of streambank protection with fencing ranges from $29 to $48/ac/yr with fencing.

2.2.1.8b Streambank Protection without Fencing

Only one source identifies costs for streambank protection without fencing. MD DNR et al. (1996) reports costs of $67/ac/yr ($75 in 2001 dollars) based on records from the MACS program. Thus, the estimated cost for streambank protection without fencing is $75/ac/yr.

The cost-share for streambank without fencing ranges from 75% to 87.5%. The sources for costs of streambank protection do not break out capital from O&M costs. Assuming that capital costs are annualized at 5% over10 years and O&M costs are 5% of the initial capital costs, capital costs represent 72% of the total annual cost. Thus, the cost-share rates apply to 72% of the annual cost estimate. For streambank protection without fencing, net farmer costs range from $28/ac/yr to $35/ac/yr.

2.2.1.9 Nutrient Management Plan Implementation

In the Watershed Model, this BMP consists of reducing fertilizer application to 130% of a crop's need. Under some plans, fertilizer may also be applied more frequently, in lower amounts that reflect more immediate soil deficiencies and crop needs. Costs result from equipment and labor for soil testing and hiring of a consultant to design the plan, plus the costs of any additional passes over the field to fertilize.

A number of sources provide cost estimates, including Camacho (1992), MD DNR et al. (1996), VA SNR (2000), USDA (1999), and U.S. EPA (2001a). Several sources suggest that landowners can save money by implementing nutrient management plans. Assuming a 3-year useful life for a plan once it is developed, and including the costs of soil testing, implementation, and, in some cases, cost savings and yield increases, net cost estimates range from -$30/ac/yr (i.e., a net cost savings) to $14/ac/yr in current dollars. A simple average is -$1.02/ac/yr, which implies a net cost savings.

However, nutrient management plans that are based on reducing phosphorus applications may require the use of custom fertilizers rather than manure, which would mean that farmers are less likely to be able to use manure generated on the farm (which is where cost savings from nutrient management plans traditionally accrue) (J. Rhoderick, MD Department of Agriculture, personal communication, November, 2002). Four sources provide sufficient cost breakdowns to calculate costs of plan development and implementation alone (i.e., without cost savings). Using a 3-year useful life for the plan, estimates based on these sources (Camacho, 1992; MD DNR et al., 1996;

USDA, 1999; U.S. EPA, 2001a) range from \$3/ac/yr to \$14/ac/yr in 2001 dollars, with an average of \$7/ac/yr in 2001 dollars. Thus, the estimated cost is \$7/ac/yr.

Most state and some federal programs provide cost-share funding for plan development and implementation. Many programs pay a fixed dollar amount per acre and others pay a percentage of costs. On a percentage basis (i.e., converting annual or annualized fixed amounts to a percentage of the estimated annual cost where necessary), the cost-share rate for this practice ranges from 28.6% to 87.5%. Thus, the estimate of the net farmer cost ranges from \$0.87 to \$5.00/ac/yr.

2.2.1.10 Grazing Land Protection

In the Watershed Model, grazing land protection refers to rotational grazing. Costs of the practice consist of permanent fencing around pastures and temporary or semi-permanent fencing around paddocks, labor to move water sources and animals between paddocks, and possibly increased administrative/monitoring costs. Some other operational costs, such as the cost of spreading manure over pasture land, may decline as a result of this practice.

Three sources provide costs for grazing land protection. Based on cost-share records from the Bay watershed, Camacho (1992) reports median total capital costs, including planning and technical assistance, of \$119 per acre (\$139 in 2001 dollars) and annual O&M costs of \$5 per acre (\$6 in 2001 dollars) for a suite of practices that includes grazing land protection, intensive rotational grazing systems, spring development, and trough/tank installation. Annualizing the capital cost at 5% over 10 years and adding O&M results in annual costs of \$24/ac/yr. USDA-ASCS (1990 and 1991, cited in EPA, 1997a) reports costs of \$10/ac/yr in the Southeast region (\$13/ac/yr in 2001 dollars), and \$35/ac/yr in the Northeast (\$45/ac/yr in 2001 dollars), for a suite of practices including critical area planting, ponds, fencing, pipeline, spring development, stock trails and walkways, troughs/tanks, water-harvesting catchments, and wells. Shulyer (1995) reports a total cost of \$2.50/ac/yr (\$3 in 2001 dollars) for a "grazing land protection" BMP that includes grazing land protection systems, spring development, and stream protection; however, this estimate it is substantially lower than estimates reported from other sources and documentation is lacking. Therefore, the average cost reflects both the Northeast and Southeast regions in USDA-ASCS (1990 and 1991, cited in EPA, 1997a) and the \$24/ac/yr estimate based on Camacho (1992), or \$27/ac/yr. Assuming a 10-year useful life for capital components and O&M representing 5% of the initial capital cost, 72% of this cost is annualized capital and therefore eligible for cost-share.

State and federal cost sharing for this practice ranges from 75% to 87.5% of installation costs. Thus, the net farmer cost ranges from \$10 to \$12/ac/yr. However, because the data sources used to derive costs for grazing land protection and the sources used to derive costs for streambank protection may include some overlapping practices, the use of these estimates may result in double-counting some costs on acres in the Watershed Model to which both BMPs are applied.

2.2.1.11 Animal Waste Management Systems

In the Watershed Model, the animal waste management system BMP refers to the construction and maintenance of facilities to handle, store, and utilize wastes generated from animal confinement operations (Chesapeake Bay Program Modeling Subcommittee, 1998). Waste management facilities may take on many forms depending on the animal species and handling method. They may include lagoons, ponds, and concrete tanks for treatment and/or storage of liquid wastes, storage sheds and pits for treatment and/or storage of solid wastes, and other structures such as concrete berms to divert waste to storage structures. The tier scenarios in the Watershed Model report animal waste management system BMP application in manure acres; one manure acre represents 145 animal units (AU), and one animal unit represents a certain number animals, depending on the species: for instance, one AU represents 0.71 dairy cows, 1 beef cow, 5 hogs, 250 layers, 500 broilers, or 100 turkeys (Chesapeake Bay Program Modeling Subcommittee, 1998).

Some of the costs for this BMP will be incurred under EPA's revised Concentrated Animal Feeding Operation (CAFO) regulations. Under these regulations, CAFOs will incur costs to implement or improve animal waste management systems, develop and implement nutrient management plans, and transfer excess manure offsite. The extent to which the Watershed Model tiers overlap costs of the CAFO Rule is unknown at this time. For instance, the Tier 1 requirements for animal waste systems indicate continuing the level of implementation based on the average rate of 1997-2000 (Exhibit 3); this level is most likely lower than would be required under the final CAFO regulations. [Note that the cost of technology-based regulations such as the CAFO rule would not be considered in analysis of substantial and widespread impact (U.S. EPA, 1995).]

Several sources contain estimates of the costs of animal waste management systems:

- MD DNR et al. (1996) reports average capital costs of $17,570 for a poultry waste system and $63,533 for other livestock system, but did not report the number of animals served by those systems and therefore the estimate cannot be converted to an average cost per manure acre

- Virginia Department of Environmental Quality (1993) reports a cost of $27,000 but does not indicate any units (e.g., whether this represents annual or one-time costs, or how many animals would be addressed)

- Tippett and Dodd (1995) reports capital costs for anaerobic lagoons of $5.60 per animal for poultry and $79 per swine and O&M costs equal to 10% of initial capital costs; however, these estimates are based on an analysis using records of state and federal cost-share funding from 1985 to 1994, although they did not convert to constant dollars before averaging

- Shulyer (1995) reports annual costs of $8,187 per manure acre, but did not document what assumptions were used to generate the annual cost (e.g., useful life, interest rate, animal species considered)

- U.S. EPA (2001a) estimated costs for model farms of varying sizes and using a range of technologies for several animal types (e.g., beef, dairy, swine, poultry); cost breakdowns for swine and poultry do not provide sufficient resolution to permit calculation of an average cost per animal unit or manure acre, but indicate an average cost per manure acre for beef ($2,114 in 2001 dollars) and dairy ($14,243 in 2001 dollars), based on annualizing capital costs over 10 years at 5%

- Camacho (1992) reports median costs per ton of wet manure treated in an animal waste management system, based on records of state and federal cost-share funding for farms in the Chesapeake Bay watershed and also based on costs from a manual prepared for the Pennsylvania Department of Environmental Resources; median costs per wet ton are $12.73 for capital ($14.83 in 2001 dollars), $2.16 for one-time planning and technical assistance ($2.52 in 2001 dollars), and $1.28 for O&M ($1.49 in 2001 dollars)

- Maryland Department of Agriculture (2002a) reports the average cost of installing a comprehensive animal waste management system for different size systems; the cost for systems that serve 100 or more animal units is $315 per animal unit (in the Watershed Model, nutrient reduction efficiencies are based on systems that service 145 animal units)

However, only the last two sources listed, Camacho (1992) and Maryland Department of Agriculture (2002a), provide sufficient information to calculate an annual cost per manure acre in constant dollars using a known interest rate, and incorporate costs for poultry waste systems.

To utilize the data from Camacho (1992), the Chesapeake Bay Program calculated the sum of capital and planning/technical assistance costs (annualized at 5% over 10 years) plus O&M costs to produce an estimate of $3.27 per wet ton of manure treated. Combining this estimate with data from the 1997 Census of Agriculture on animals in the watershed counties, and standard assumptions about manure excreted for different animal species (shown in **Exhibit 9**), produces an average cost per manure acre in the watershed. Based on the weighted average value of 12.52 tons of manure excreted per animal per year in the watershed counties, the average annual cost per manure acre is $5,932 (equal to $3.27 per wet ton manure treated times 12.52 tons wet manure per animal unit per year times 145 animal units per manure acre).

Exhibit 9: Derivation of Average Manure Excretion in Bay Watershed

Species	Animals Per Animal Unit	Wet Manure Excreted (tons/animal unit/yr)	Equivalent Wet Manure Excreted (tons/animal/yr)	Animals in Watershed Counties[1]	Animal Units in Watershed Counties
Dairy	0.71	14.9	20.99	1,383,201	1,948,170
Beef	1	6.7	6.7	661,807	661,807
Swine	5	11.7	2.34	265,743	53,149
Layers	250	9.7	0.04	110,725	443

Exhibit 9: Derivation of Average Manure Excretion in Bay Watershed

Species	Animals Per Animal Unit	Wet Manure Excreted (tons/animal unit/yr)	Equivalent Wet Manure Excreted (tons/animal/yr)	Animals in Watershed Counties[1]	Animal Units in Watershed Counties
Broilers	500	13.1	0.03	1,861,093	3,722
Turkeys	100	10.2	0.1	nd	nd
Weighted average[2]	n/a	12.52	n/a	n/a	n/a

Sources: Animals per animal unit and wet manure excreted from Gilbertson, 1979, cited in Chesapeake Bay Program, 1998; animal populations from USDA-NASS, 1999. nd = No data; n/a = not applicable.

1. Number of animals in watershed counties indicates inventory of animals in 1997, except broilers, which indicates number sold in 1997.
2. Average is weighted by number of animal units by species in watershed counties in 1997.

The Chesapeake Bay Program used similar assumptions to derive an annual cost based on the data from MDA (2002a). Annualizing the capital cost of $315 per animal unit at 5% over 10 years results in an annual cost of $41/animal unit/yr. Adding O&M costs equal to 10% of the initial capital cost (i.e., 10% x $315) results in an annual cost of $72/animal unit/yr, or $10,440 per manure acre per year. Averaging the estimates from Camacho (1992) and MDA (2002a) produces an annual cost of $8,186 per manure acre per year. Approximately 56% of this cost is annualized capital and therefore eligible for cost-share.

Cost sharing is provided by various programs including EQIP and several state programs. Cost share percentages range from 75% to 87.5% of installation costs. The net farmer cost, therefore, ranges from $4,175 to $4,748/manure acre/yr.

2.2.1.12 Yield Reserve

The yield reserve BMP involves applying 75% to 85% of the fertilizer recommended in a nutrient management plan (i.e., 98% to 111% of a crop's need instead of 130%). This BMP is only applied in the Tier 3 scenario. Costs consist of development and application of an NMP ($7/ac/yr, as described above). To encourage participation in a federal pilot program, the proposed program has an incentive payment of $40/ac/yr (which may fall to $20/ac/yr to $30/ac/yr in a subsequent bid program phase) and also provides insurance against revenue losses associated with lower crop yields (personal communication with T. Simpson, University of Maryland, March 2002). In the long run, the cost of this program could equal annual revenue on the order of $20/ac/yr less than the NMP cost, or net revenue of about $13/ac/yr. However, a dedicated Yield Reserve program was not included in the 2002 Farm Bill, and although various opportunities remain to fund a program through other parts of the Bill or through other sources (personal communication with T. Simpson, University of Maryland, May 2002), the potential cost savings are not included (i.e., the estimate is $0/ac/yr instead of -$13/ac/yr).

2.2.1.13 Carbon Sequestration/Bio-Energy

The carbon sequestration BMP is potentially an extension of the retirement of highly erodible land and grass buffer strip BMPs. Similar to these BMPs, the land owner plants permanent grass cover (such as switchgrass) and maintains it for 10 years or longer. This BMP differs, however, in that the land owner is allowed to harvest top growth and sell it as a biofuel for electricity generation or co-generation. If the biofuel is used in a co-fired coal plant, then it generates CO_2 offsets through fuel substitution. Also, continuous switchgrass ground cover is expected to sequester soil carbon in the root zone because only the top growth is harvested.

Annual harvest of switchgrass for biofuel increases the cost of this BMP. Turhollow (2000) estimates that the average "delivered" cost (i.e., including transportation) per ton of harvestable biomass is $52 (1999$). This cost incorporates costs for establishment (which includes land rent), maintenance, harvest, and transportation. Given his average yield rate of 5 tons per acre per year, the cost per acre is $260 (5 x 52). At issue is whether potential revenues for biofuel and carbon sequestration can offset this cost or at least the incremental cost of biofuel harvest and transportation.

Potential revenue sources include (1) annual sale of biomass as a fuel source for a co-fired coal and biomass generator, (2) value of CO_2 credits for replacing fossil fuel with biomass fuel, and (3) value of CO_2 credits for additional soil carbon sequestration. **Exhibit 10** provides revenue estimates that indicate a potential for revenue from all three sources to nearly offset the $260/acre annual cost (revenues range from $229/acre to $261/acre).

This is not a contractual BMP and, therefore, there is no reason to expect a farmer to incur annual harvest and transportation costs if the fuel sales and CO_2 credits for fuel-switching do not offset annual costs. Therefore, the maximum cost for this BMP is the installation cost, which is $100/acre in 1999 dollars (Turhollow, 2000). Converted to 2001 dollars and annualized at 5% over 10 years, the cost is $13/ac/yr. It is conceivable, however, that the additional sources of revenue could result in a lower average cost, which would mean that the estimate exceeds the actual cost of this BMP.

Exhibit 10: Estimates of Potential Revenue for Carbon Sequestration BMP

Source	Assumptions	Revenue/Acre
Fuel Sales	5 tons/acre annual average yield[1] x 15 million Btu/ton (MMBtu/ton)[2] x $1.05 per MMBtu[3]	$79
CO_2 fuel-switching credits	5 tons/acre annual average yield[1] x 15 MMBtu/ton[2] x 178 lbs CO_2/MMBtu coal[4] ÷ 2000 lbs per ton x $20/ton CO_2[5]	$134
CO_2 sequestration credits	0.2–0.66 tons carbon/acre annual average sequestration rate[6] x 44/12 conversion factor from carbon to CO_2 x $20/ton CO_2[5]	$16–$48[7]
Total		$229–$261

1. Midpoint yield rate from Turhollow (2000) and Walsh and Lichtenberg (1995).
2. Heat content of switchgrass (Turhollow, 2000).
3. Projected delivered price of coal for electric generation in 2010 in 2000 dollars (EIA, 2001).
4. Projected CO_2 emissions rate for supercritical pulverized coal generation in 2010 (DOE, 2002). This analysis assumes net biomass emissions of zero (i.e., annual sequestration in biofuel portion of biomass offsets its annual combustion emissions). Thus, total avoided CO_2 emissions equals avoided coal CO_2 emissions.
5. Approximate upper bound of observed past trades (CO2e.com).
6. Calculated from 0.5 to 1.5 tons per hectare rate in CAST (1998).
7. This range is similar to the range of $20 to $25 per acre revenue for carbon sequestration submitted in a comment by R. Handley (Project Director, Northeast Regional Biomass/Biofuels Program, Coalition of Northeastern Governors). The cost-per-acre for planting and harvesting in this comment is $55 to $65, which is substantially less than the potential biofuel revenue alone.

2.2.1.14 Manure Excess

In the Watershed Model, this BMP represents implementation of alternative uses for excess manure from livestock operations, as opposed to spreading manure on fields. The practice may be necessary either because of declining agricultural land on which to spread the manure, or because of nutrient management plans that reduce land application. In the Watershed Model, BMP implementation requirements are expressed in units of wet tons of manure that must be exported per year.

Based on model farm cost estimates developed for the economic analysis of the proposed CAFO rule (U.S. EPA, 2001a), the estimated cost is $3.11 per wet ton per year, and represents an average across different beef and dairy farm sizes in the Mid-Atlantic states as well as transportation options and nutrient application limitations.

Cost-share funds for manure transportation off farms are available in Maryland through the Manure Transportation Program and in Delaware through the Nutrient Management Relocation Program. As of May 2002, the Maryland program was scheduled to pay 12 cents per ton-mile (or 15 cents on the Eastern Shore), plus a $1.50 per ton load rate, up to $20/ton-mile, for poultry litter. The program would also pay generally 87.5% of costs for transporting manure of other animals, subject to caps depending on moisture content and distance (personal communication with N. Astle, Maryland Manure Transportation Program, May, 2002). However, in Maryland the recipient of the manure generally pays the remaining costs of transportation, so that the net cost to the producing farmer is zero, or the farmer may even make positive returns in the process of selling the manure (personal communication with N. Astle, May, 2002).[9] The Delaware program pays 15 cents per ton-mile plus a $2.50 per ton load rate up to $20 per ton (Delaware Department of Agriculture, 2002b).

For Maryland and Delaware, the costs for hauling manure are cost-shared so the net cost to farmers is zero. In other states with no cost-share the net farmer cost is $3.11 per ton.[10]

2.2.1.15 Conservation Tillage

In the Watershed Model, conservation tillage (CT) is defined as leaving at least 30% of the crop residue on the field between crops and reducing disturbance of the soil surface/upper horizon. Several sources of cost information indicate that CT is well-accepted by agricultural producers. For example, Tippett and Dodd (1995) note that the federal government gives incentive payments to encourage the practice for the first three years, after which time it is hoped that farmers see net benefits and continue to use the practice on their own.

The main cost driver for this practice is the possible purchase of new equipment appropriate for the conservation tillage system. Because conservation tillage must be rotated with conventional tillage to avoid soil compaction, the practice requires the purchase or rental of equipment for both types of tillage systems (conventional and conservation). The only study that specifically states equipment costs are included is MD DNR et al. (1996), which reports a cost of $17/ac/yr (or $19 in 2001 dollars). However, it appears based on reviewing the source of that estimate (as cited in the document) that the cost actually represents incentive costs rather than equipment costs. Therefore, additional research is required to document an average annual cost per acre.

Excluding such costs may not substantially bias the analysis. Many farmers are already implementing conservation tillage and, therefore, have already purchased equipment. Indeed, many of the net conservation tillage acres in the tier scenarios are negative, indicating high implementation rates in Progress 2000. To the extent bias exists, it is primarily an underestimate of costs to cost-share programs, which provide incentive payments for implementing this practice and tax credits for purchasing equipment.

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[9] Recent budget shortfalls in Maryland have decreased the amount provided under the cost-share program. The availability of future funding is unknown because projecting state budget outcomes is impossible; this issue can be dealt with in a sensitivity analysis.

[10] The estimated cost assumes manure is hauled an average distance of 18 miles from the producing farm, which is the average haul distance calculated by the U.S. EPA (2001a) for the CAFO Rule in the mid-Atlantic region. Longer hauling distances may be likely for farms on the Delmarva Peninsula. Net farmer costs are likely to remain zero for Delaware and Maryland farms, but the funds necessary for cost-share may increase.

Several additional sources also use government incentive payments rather than actual equipment or practice costs. These sources (MD DNR et al., 1996; Camacho, 1992; Tippett and Dodd, 1995; and VA SNR, 2000) report incentive payments around $15 to $25/ac/yr in current dollars, or about $20-25/ac/yr in constant 2001 dollars. Camacho (1992) notes that the incentive payments do not reflect practice costs. The four studies that estimate practice costs find net costs ranging from $-2/ac/yr (i.e., a net revenue gain of $2) to $5.60/ac/yr. Some variation is a function of what crop rotation is assumed; USDA (1999) estimates that conservation tillage in corn results in a net gain, while the practice results in net costs for soy and wheat.

The average of the practice costs from USDA (1999), Smolen and Humenik (1989, cited in U.S. EPA, 1997b), and Russell and Christensen (1984, cited in U.S. EPA, 1997b) is $2.72/ac/yr. This cost probably excludes any additional equipment costs that might be incurred (if farmers buy new equipment sooner than necessary rather than waiting until existing equipment needs to be retired), but it also excludes incentive payments from cost-share programs. Assuming that these costs balance each other, the net farmer cost is $2.72/ac/yr. There is inadequate data regarding the prevalence of equipment purchase related to implementation to incorporate state or federal funding applicable to the purchase of equipment for this BMP.

2.2.2 Forestry

In the Watershed Model, forest harvesting practices represent a suite of practices to control erosion on forest land harvested for timber. Practices may be either structural (e.g., culverts, broad-based dips, windrows) or managerial (e.g., preharvest planning, forest chemical management, fire management). Several sources provide cost estimates:

- Aust et al. (1996, cited in U.S. EPA, 2001b) estimated costs for implementation of various erosion control practices in Virginia and southeastern states, and reported costs per acre for "stringent, enforceable implementation" of $21.40/ac for the coastal plain, $38/ac for the Piedmont, and $49/ac in the mountains (1998 dollars); these costs appear to include technical assistance, quality control, and compliance

- South Carolina Forestry Commission (1993, cited in MD DNR et al. (1996), estimated costs of $12.15/mbf (1 mbf = 1,000 board feet) for loblolly/shortleaf, which is characteristic of flat sites, $14.31/mbf for oak/pine, which is characteristic of moderately sloped sites, and $14.50/mbf for oak/hickory, which is characteristic of steep sites (dollar year not reported); using data on board-feet of timber per acre in Maryland by topographic region from Frieswyk and Giovanni (1988) in MD DNR et al. (1996), this equates to $129/ac on flat sites, $152/ac on moderate sites, and $172/ac on steep sites (dollar year unknown)

- Lickwar, Hickman, and Cubbage (1992) estimated costs of $2.42/mbf or $12.56/ac on flat sites, $4.75/mbf or $24.33/ac on moderately sloped sites, and $6.08/mbf or $34.62/ac on steep sites (1987 dollars)

- Virginia Department of Environmental Quality (1993) estimated costs of $51/ac/yr (dollar year not reported) including construction, planning, technical assistance, and

O&M (based on annualizing capital costs at 10% over an unspecified practice life); however, this estimate is not usable because many assumptions are not documented.

Converting estimates from Aust et al. (1996, cited in EPA, 2001b), South Carolina Forestry Commission (1993, cited in MD DNR et al., 1996), and Lickwar, Hickman, and Cubbage (1992) into 2001 dollars (using the USDA-ERS index of prices paid by farmers (USDA-ERS, 2001), and assuming the costs in the South Carolina Forestry Commission report are in 1993 dollars, results in an average cost across the three land types of $84/ac/yr. Although this average does not reflect the Virginia DEQ (1993) report due to lack of documentation, the average value of the other three sources is comparable to the DEQ estimate of $51/ac/yr (after accounting for inflation in the latter estimate) and is also conservative.

The costs from the three sources appear to reflect total costs, rather than annual costs. However, the number of acres to which the BMP is applied is expressed as a number per year, and the BMP is likely to be applied to new land every year rather than previously harvested land. If previously harvested land is re-harvested (i.e., if selective harvests are performed on the same land more than once before 2010) and the BMP implemented previously can be re-used (e.g., a culvert that would not be damaged in the later harvest), the unit cost for this BMP will tend to be overstated.

The Forest Lands Enhancement Program, recently created by the 2002 Farm Bill, may provide public funds for landowners to implement erosion control practices during forest harvesting. However, the summaries of costs shown in Section 3 do not incorporate the potential for public cost sharing through this program.

In addition, Dissmeyer and Foster (1987, cited in EPA, 2001b) found that forest harvesting practices resulted in net cost savings in some cases in southern states due to avoiding problem soils, wet areas, and unstable slopes, and reducing erosion by revegetating cut and fill slopes. Thus, in areas where forest harvesting measures result in net cost savings, the cost estimate will overstate actual BMP costs.

2.2.3 Urban and Mixed Open Land

2.2.3.1 Forest Buffers

The cost to plant and maintain a forest buffer on agricultural land is also applicable to forest buffers on pervious urban and mixed open lands. One would expect that the cost estimate for the urban version of this BMP would be lower than the agricultural cost estimate because it excludes the foregone revenue of planting a buffer on cropland. However, the land rental payments under the CRP or CREP programs likely offset this net revenue impact among farmers. Consequently, the cost is $108/ac/yr for urban and agricultural buffers.

The net cost for agricultural tree buffers incorporates a cost share that ranges from 75% to 100% of installation costs. There is at least one cost-share program for urban forest buffers, the Maryland Buffer Incentive Program (BIP). This program provides private landowners with a one-time payment of $300/acre up to a maximum of $15,000 for planting and maintenance of riparian forest buffers; the program provides funding for about 300 acres ($90,000) per year (Environmental Law Institute, 2000). The estimates do not reflect this cost-share program. Palone and Todd (1998) provide some estimates of increases in lot value for lots adjacent to forest buffers, but the estimates also do not reflect offsets of this type because it is unknown whether the nonagricultural forest buffers are planted on private or public lands.

2.2.3.2 Environmental Site Design

The environmental site design (ESD) BMP, also called Low Impact Development (LID), is applied to land area under new development. The U.S. EPA (2000, p. 1) defines LID as

> a site design strategy with a goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic landscape. ... LID principles are based on controlling storm water at the source by the use of micro-scale controls that are distributed throughout the site. This is unlike conventional approaches that typically convey and manage runoff in large facilities located at the base of drainage areas.

Because this BMP is applied to newly developed acres, the cost-per-acre must incorporate the cost savings associated with avoided storm water conveyance structures (e.g., curbs, gutters, and underground pipe) as an offset to the cost of ESD measures themselves. LID practices include bioretention, grass swales, vegetated roof covers, and permeable pavements. The concept is that investing in permeable substitutes to traditional impervious surfaces avoids the cost of the surface itself, and the corresponding costs of the infrastructure required to handle its storm water runoff.

Presently, the cost information for this innovative approach to land development is anecdotal and much of the information is qualitative. The U.S. EPA (2000) states that LID practices are more cost effective compared to conventional storm water structures and also provide more aesthetic landscape features. An earlier literature review (U.S. EPA, 1996) provides some case study examples showing net cost savings of practices that can be considered LID, e.g., a $100,000 rain garden versus $400,000 for conventional storm water ponds in the Somerset project in Prince George's County, MD. The NAHB Research Center, Inc. and U.S. EPA (2001) note the following cost implications for LID measures:

- Bioretention: minimal net construction costs because higher landscaping costs could be offset by lower storm water management costs elsewhere; low maintenance costs

- Swales and grassy channels: lower costs compared to paved or impervious infrastructure (one-half to one-third the cost of curb and gutter systems), low maintenance costs, decreased requirements for downstream facilities and related infrastructure costs

- Permeable paving: higher upfront costs and maintenance, but reduced need for storm water facilities help offset the initial cost differential.

A couple of case studies cited throughout the literature provide evidence that net costs are potentially negative (i.e., the ESD costs are lower than conventional impervious surface/storm water infrastructure investments). A study cited by the NRDC (2001) and the NAHB Research Center, Inc. and U.S. EPA (2001) is the redesign of a 130-acre development project in Sherwood, Arkansas. **Exhibit 11** provides a comparison of key development parameters between the original convention design and the revised design that preserved natural vegetation and drainage features, thereby reducing site preparation and storm water infrastructure costs. The cost comparison indicates that the latter reduced total costs by 15% and the cost per lot by 19%. The per-lot savings is higher because the revised design also increased the number of housing units.

Exhibit 11: Cost and Development Implications of Alternative Designs

Development Parameters	Conventional Development Plan	Green Development Plan
Lot yield	358	375
Street (linear ft.)	21770	21125
Collector street (linear ft.)	7360	0
Drainage pipe (linear ft.)	10098	6733
Total cost estimate	$4,620,600	$3,942,100
Cost per lot	$12,907	$10,512
Incremental amenities	na	23.5 acres open space/parks
Incremental lot value	na	$3,000 over competitors

Source: NAHB Research Center, Inc. and U.S. EPA (2001), citing Tyne and Associates. 2000. "Bridging the Gap: Developers Can See Green." Land Development Spring/Summer: 27-31.

Two other case studies that provide cost information include:

- a project design that included bioretention areas, rain gardens, compact weir outfalls, depressions, grass channels, wetland swales, and a specially designed storm water basin at a new 270-unit apartment complex in Aberdeen, NC, reduced storm water costs by 72% or $175,0000 compared to a traditional storm water collection system by eliminating nearly all subsurface infrastructure along with curbs and gutters (BLUE Land, Water, Infrastructure, 1999)

- developers for the Pembroke Subdivision in Frederick County, MD, were able to eliminate plans for two storm water management ponds using LID practices (thereby avoiding $200,000 in infrastructure costs), preserve a two-and-a-half acre open space and wetlands, which provided wetland mitigation savings, add two lots to the 43-acre development (adding $100,000 in value), and preserve almost 50% of the site in undisturbed wooded condition (NRDC, 2001)

Thus, the expectation is that incorporating ESD measures in new development is likely to reduce costs and the case study data for new developments indicate potential for net cost savings. Developing an average cost savings per acre, however, is not feasible given the limited data.

Consequently, the net cost estimate of $0/acre reflects that any incremental ESD planning and implementation costs are completely offset through cost savings in avoided costs for conventional storm water management infrastructure that is required in most developments to handle the volume of storm water generated by creating impervious surfaces.

2.2.3.3 Storm Water Retrofits

The per-acre BMP costs for storm water retrofits distinguish between costs for pervious and impervious urban areas. In either case, there are a variety of practices that might be implemented; the choice of practice depends on a variety of site-specific conditions (e.g., site imperviousness, site size, climate, and land availability) that vary throughout the basin. Consequently, the unit costs reflects a wide variety of measures, including new construction (e.g., detention ponds, retention ponds, infiltration basins, swales, and sand filters) and retrofits to existing infrastructure (e.g., converting storm water management ponds to extended detention ponds). The costs are averages across three sources:

- Brown, W., and T. Schueler. 1997. The Economics of Storm water BMPs in the Mid-Atlantic Region. Final Report prepared by the Center for Watershed Protection (CWP) for the Chesapeake Research Consortium. As reported in related CWP documents and databases, including CWP. (no date). The Economics of Storm Water Treatment: An Update. Technical Note #90 from Watershed Protection Techniques 2(4): 395-499.

- Northern Virginia Planning District Commission (NVPDC). 1994. Urban Retrofit Techniques: Applicability, Costs, and Cost-Effectiveness. Prepared for Virginia Department of Environmental Quality.

- Livingston, E.H. 1999. "A Review of Urban Storm water Retrofitting in Florida." In *Proceedings of the Comprehensive Storm water & Aquatic Ecosystem Management Conference*, Auckland, New Zealand, February 22-26, 1999.

These studies provide cost estimates for a wide variety of BMPs designed for existing development. BMPs include actual retrofit projects as well as new construction. **Exhibit 12** shows mean unit costs for each study distinguish between pervious and impervious area, where feasible. In most cases, the cost estimates represent the total cost to treat both water quantity and water quality volumes since the retrofits must be conservatively sized to handle the total volume of storm water runoff. The costs represent costs per acre controlled in the watershed area, not costs per project acre.

Exhibit 12: Mean Annual Storm Water Retrofit Costs (2001 dollars per acre)[1]

Source	Pervious Urban Area	Impervious Urban Area
Brown and Schueler (1997)[2]	$287	$1,013

Exhibit 12: Mean Annual Storm Water Retrofit Costs (2001 dollars per acre)[1]

Source	Pervious Urban Area	Impervious Urban Area
NVPDC (1994)[3]		
Retrofit structures	$289	$289
New structures	$451	na
Livingston (1999)[4]	$312	$1,164
Mean across studies	$330	$820

Note: Capital costs from all studies are converted to 2001 dollars using the construction cost index in the Engineering News Record. Annualized capital costs are based on the assumption that financing terms of 5% over 20 years are available to municipalities. The interest rate is higher than borrowing rates for State Revolving Fund loans, which range from 0.7% to 3.9% throughout the basin states, to reflect that possibility that some municipalities may use alternative financing arrangements such as revenue bonds or bank loans, which tend to have higher rates. Costs include either annual O&M estimates provided by the study or annual O&M costs equal to 5% of total capital costs (CWP, no date).

1. Represents total structural costs, including costs to control storm water quantity as well as quality.
2. Example costs from CWP (no date) for a 50-acre residential development and a 5-acre commercial development to demonstrate the cost function derived in Brown and Schueler.
3. Average new structure costs based on 22 projects implementing a variety of technologies including wet pond creation and sand filter installation. Average retrofit costs are based on calculated averages for sites of 5 to 300 acres for five cost functions reported in the paper. Costs for retrofitting existing flood control structures do not differ by degree of perviousness.
4. Averages for various low-density and high-density retrofit projects throughout Florida.

Although the average cost for impervious urban areas represents an average over a wide range of site conditions, it may be too low to represent potential costs to retrofit ultra-urban places, which are large, densely populated areas. These areas can have limited space for constructed BMPs in conjunction with high runoff volumes generated by a high percentage of impervious surface.

Exhibit 13 shows populations, population density, and land area for urban areas in the Basin with more than 70,000 people (based on 2000 census data for population and land area). The places with population densities of over 10 people per acre (shown in bold in the table) may experience higher costs associated with storm water controls due to the space limitations discussed above: Baltimore, MD, Washington, D.C., Arlington, VA, Alexandria, VA, and Silver Spring, MD. Five storm water retrofit projects reported in Livingston (1999) treat water from areas with impervious surface accounting for 85% or more of total surface area. The cost-per-acre estimates (in 2001 dollars) for these highly urbanized areas are:

- $682/acre to install a detention pond and sand filter for a 9.2-acre medical complex in Pinellas County
- $699/acre for a wet detention pond and treatment system for a 121-acre site in Orlando
- $1,005/acre for a berm, weir, and pump system to reuse "first flush" from an 8.1-acre site for irrigation in Winter Park

- $3,269/acre for an alum injection system and lake restoration project for a 158-acre site in Tallahassee

- 4,986/acre to install an infiltration retrofit in a 2-acre parking lot in North Redington Beach.

Exhibit 13: Urban Places in the Chesapeake Bay Basin with Population > 70,000 (ultra-urban places in bold)

Urban Place	Population (2000)	Population Density (people/acre)	Size (square miles)
Baltimore city (MD)	651,154	12.6	80.8
Washington, D.C.	572,059	14.6	61.4
Virginia Beach city (VA)	425,257	2.7	248.3
Norfolk city (VA)	234,403	6.8	53.7
Chesapeake city (VA)	199,184	0.9	340.7
Richmond city (VA)	197,790	5.1	60.1
Arlington city (VA)	189,453	11.4	25.9
Newport News city (VA)	180,150	4.1	68.3
Hampton city (VA)	146,437	4.4	51.8
Alexandria city (VA)	128,282	13.2	15.2
Portsmouth city (VA)	100,565	4.7	33.2
Columbia city (MD)	88,254	5.0	27.6
Silver Spring city (MD)	76,540	12.7	9.4
Scranton city (PA)	76,415	4.7	25.2

These estimates produce an average cost of $1,930/acre for retrofits in ultra-urban areas. Stormwater control costs generally do not include land acquisition costs because most of the control technologies either require relatively little land area (e.g., infiltration basins) or do not require additional land purchase (e.g., retrofitting an existing detention pond to extend detention time).

Data provided by the Maryland Department of the Environment suggest that these estimates may overstate retrofit costs. A report of six case studies (MDE, 1997) indicates total capital costs that potentially range from $1,051 to $3,553 per acre; corresponding annualized costs would range from $84 to $285. A second set of 11 retrofit projects have a mean total cost of $3,529 per acre and an annualized cost of $283 per acre (S. Bieber, MD Department of Environment, personal communication, May, 2002). However, sufficient information to incorporate these data is not available.

There may be potential for cost savings through "piggybacking" storm water retrofits onto planned road or other infrastructure maintenance to reduce costs. An example provided by the Prince Georges County (MD) Department of Environmental Resources (personal communication with L. Coffman, 8/8/02) demonstrated how the cost of a particular storm water facility, a roadway bioretention system, might be cut by 46% if the system could be installed as part of a planned road repair activity. The cost savings accrue because some of the excavation and fill work cost is incurred for road repair regardless of whether a bioretention system is added. Thus, the incremental cost of bioretention is only 54% of the cost of a typical system.

This particular example does not provide enough information to incorporate potential cost-savings into the unit cost estimate for retrofits because the original retrofit cost studies do not include bioretention systems. However, this example suggests the possibility that piggybacking opportunities may reduce costs for other storm water management technologies.

The unit cost estimates already incorporate potential cost savings opportunities to some extent because some case study costs come from retrofitting existing storm water facilities. For example, the unit cost for impervious urban land is an average of three values: $1,164/acre/yr for a set of Florida case studies with unit costs ranging from $682/acre/yr to $2,269/acre/yr; $1,013/acre/yr from a function for detention pond costs estimated by Brown and Schueler based on case studies in the Mid-Atlantic region; and a $289/acre/yr average cost for retrofit projects for existing detention ponds in the Anacostia watershed. Thus, low-cost opportunities to alter existing storm water facilities are incorporated by including the Anacostia retrofit costs in the average unit cost estimate. Although piggyback opportunities may further reduce costs for storm water retrofits, further adjustments to the cost estimates derived above are not warranted because they already incorporate the effect of cost-savings opportunities.

2.2.3.4 Storm Water Management

This control is applied to new development that occurs between 2000 and 2010.[11] Although it will incorporate many of the same structural controls as retrofits, the unit cost estimates for this measure are lower because only the water quality volume is relevant since costs associated with water quantity will be borne regardless of water quality considerations. New development in urban areas is generally required to have infrastructure to quickly remove storm water from surface areas and store it while it is gradually released. Therefore, a portion of storm water management costs in new development would be incurred regardless of water quality concerns.

Exhibit 14 reports costs associated with water quality volumes for the three studies included in the retrofit section as well as a fourth study that provides costs for only the water quality volume. The BMP cost estimate is based on the mean values across all the studies ($150 on pervious and $450 on impervious urban areas).

Exhibit 14: Mean Annual Storm Water Management Costs (2001 dollars per acre)[1]

Source	Pervious Urban Area	Impervious Urban Area
Brown and Schueler (1997)[2]	$96	$338

[11] The Watershed Model also includes a storm water management BMP on recent development to account for reduced loadings from development that occurred between 1986 and 2000 compared to prior development. Costs incurred prior to 2000 are not addressed here.

Exhibit 14: Mean Annual Storm Water Management Costs (2001 dollars per acre)[1]

Source	Pervious Urban Area	Impervious Urban Area
NVPDC (1994)[4]	$150	na
Livingston (1999)[5]	$174	$460
U.S. EPA (1999b)[6]	$200	$552
Mean across studies	$150	$450

Note: Capital costs from all studies are converted to 2001 dollars using the construction cost index in the Engineering News Record, and amortized at 5% over 25 years. Annual O&M costs estimated as 5% of total capital costs (CWP, no date).

1. Represents the share of BMP costs attributable to storm water quality requirements.
2. Example costs from CWP (no date) for a 50-acre residential development and a 5-acre commercial development to demonstrate the cost function derived in Brown and Schueler.
4. Average new structure costs based on 22 projects.
5. Average costs for low-density and high-density projects throughout Florida.
6. Averages across subsets of costs for five different structures; water quality share only (based on functions in the study).

2.2.3.5 Urban and Mixed Open Nutrient Management

Urban and mixed open nutrient management involves a reduction of fertilizer applications to urban and mixed open land to reduce nutrient loadings. Although the principles and objectives of urban nutrient management are similar to its agricultural counterpart, there is one important difference–nutrient application in urban settings is not an essential input to food production. This means that although the costs associated with conducting soil samples and developing agronomically appropriate nutrient application rates are potentially transferrable to urban settings, any net revenue impact associated with yield reductions or increases is irrelevant. Furthermore, given the largely voluntary nature of urban nutrient application, it is difficult to justify a BMP unit cost assumption that would impose burdensome costs on urban households, through either direct household consumption of application services or indirect tax or fee increases to fund municipal landscape programs.

Consequently, the cost estimate is equal to the soil testing and plan development portion of the agricultural BMP cost. Only two sources are sufficiently documented to break out these costs from implementation costs; these two sources report costs of $5/ac (USDA, 1999), or $5.16/ac in 2001 dollars, and $7/ac (U.S. EPA, 2001a), or $7.22/ac in 2001 dollars, for plan development and soil testing. The mean cost is $6.19/ac; assuming the plan is good for 3 years, the annual cost is $2.06/ac/yr. This is consistent with incremental costs identified by MD DNR (E. Kanter, personal communication, 2002). Incremental application costs are unlikely because households and municipalities will minimize these types of cost impacts. State agencies and local communities might incur incremental administrative costs, but these costs are *de minimis* when converted to a per-acre basis because the BMP applies to millions of acres. Depending on state program requirements, businesses might also have additional record keeping or paperwork requirements (e.g., recording soil sample and nutrient application rate information for each customer). States can choose, however, to implement requirements that minimize these impacts on businesses (e.g., simply requiring some additional fields in customer databases to track soil sample results and nutrient application rates).

In the Watershed Model, this BMP is applied to both pervious urban and mixed open land. For pervious urban land, the estimated cost is \$2.06/ac/yr. For mixed open land (defined as herbaceous land other than agricultural land), the estimate is one quarter of this cost (\$0.52/ac/yr) based on information about mixed open land from the Chesapeake Bay Program Modeling Subcommittee (Chesapeake Bay Program, 2000). This document states that mixed open land has a fertilizer application rate equal to 25% of the rate for pervious urban land. The cost of \$0.52/ac/yr represents a weighted average cost between 25% of acres to which fertilizer is applied and 75% of acres where the cost of fertilizer management is zero because no fertilizer is applied (either before or after implementation of the BMP).

One option for implementing this BMP is public education and outreach to urban and suburban residents to encourage lower fertilizer application. Two analyses provide cost estimates for an outreach program: a study of a community outreach program in Kettering, MD (Coffman, 2001), and the economic analysis of the Phase II Storm Water Rule (EPA, 1999b).

The first study was conducted by the Prince George's County Department of Environmental Resources (PGDER) in the town of Kettering, (population 2,800). Kettering and the PGDER implemented the outreach program in 1993-94 as a learning tool to determine what outreach efforts were most effective. The program covered many topics (including several unrelated to nutrient management, such as car care, backyard habitat, and recycling) and used numerous educational methods, including a monthly newsletter mailed to all households, workshops, regular water quality monitoring, and storm drain system monitoring to look for illegal discharges and connections. A full-time project manager supervised the program, aided by a citizen advisory committee. The project cost about \$84,000, or about \$75 per household (dollar year not provided). However, pre- and post-program surveys suggested that behavioral changes were minimal. The Kettering study is not incorporated for the following reasons:

- Most of the program's pollution reduction objectives (e.g., recycling, car products, and hazardous waste) are not included in the Bay watershed nutrient reduction scenarios

- The study gave no evidence that any of the outreach tools used were cost-effective

- Some alternatives to outreach suggested by the study, such as LID, are already implemented in the watershed scenarios.

The Economic Analysis of the Final Phase II Storm Water Rule (EPA, 1999b) also included an analysis of public education and outreach costs related to reducing pollutant loadings, including nutrients, from urban and suburban households. The National Association of Flood and Stormwater Management Agencies (NAFSMA) conducted a survey in 1998 of 1,600 jurisdictions to identify costs of existing programs for public education and outreach, illicit discharge detection and elimination, construction site storm water runoff control, post-construction storm water management in new and recent development, and pollution prevention for municipal operations. Fifty-six jurisdictions responded with usable cost and household data; the mean cost per household for all five of those activities is $9.16 per year (1998 dollars). A breakout is not provided; however, public education and outreach for nutrient control likely makes up a relatively small portion of the costs. Estimates from this source cannot be incorporated because no breakout is provided; however, the NAFSMA study appears to corroborate the idea that per-household or per-acre costs for this BMP would be relatively low.

2.2.3.6 Urban Land Conversion

In the Watershed Model, urban land conversion is a 10% to 20% reduction in planned new development acres in Tiers 2 and 3, respectively. These acres mostly represent conserved forest land and agricultural land. There are no corresponding changes in 2010 population or housing unit estimates, which implies that this BMP is achieved through a variety of approaches that do not affect overall population growth. Approaches include using infill or brownfield development in place of greenfield development, building up instead of out, and clustering greenfield development to preserve natural areas and mature trees.

Net cost estimates for any of these approaches will equal incremental development costs (e.g., additional planning/design costs, additional administrative costs/fees, and higher costs for "building up" structural materials) minus cost savings (e.g., reduced site preparation costs and reduced infrastructure costs for road and utility services) and increased property values. Thus, net BMP costs reflect net revenue impacts to developers.

Literature reviews (Redman/Johnston Associates, Ltd, 1998; U.S. EPA, 1998) provide several case studies that demonstrate infrastructure cost savings and/or increased property values that are substantial enough to offset incremental development costs. For example, the cost of providing utilities for low-density development can be almost two times higher than the cost for compact development (Pelley, 1997). Delaware case studies, cited in CWP (1998), report cost savings ranging from 39% to 63% for new cluster developments that preserved woodland areas in addition to reducing street widths and implementing vegetated BMPs.[12] Furthermore, leaving mature trees on a site can bring about premium property values (NAHB Research Center, Inc. and U.S. EPA, 2001).

Any incremental planning costs and net revenue impacts are likely completely offset by infrastructure cost savings and property value increases. Thus, there is no net revenue impact for the developer.

[12] Reduced road widths and vegetated BMPs that promote onsite infiltration are considered part of the ESD BMP. Thus some of the cost savings in these case studies would be attributed to ESD and some to urban growth reduction.

2.2.3.7 Forest Conservation

Forest conservation, which occurs only in the 2000 Progress scenario, is patterned after the Maryland Forest Conservation Act, which seeks to preserve existing forest land that is at risk during land development and plant trees in developed areas. Until actual program costs are available, the unit cost estimate for this BMP equals the weighted average cost across two conservation scenarios. In the first scenario, a developer sets aside already forested land onsite for preservation. In the second scenario, tree planting occurs in an off-site location.

The unit cost estimate for the first scenario is the same as the urban growth reduction BMP. The cost for that BMP is $0/ac/yr, which assumes that any incremental costs associated with development plans that conserve forested acres are offset by cost savings and incremental property values.

For the second scenario, the planting and maintenance cost components reflect the forest buffer cost estimate developed for agricultural land. The cost for this BMP is $108/ac/yr. No cost-sharing is available as in the agricultural sector although lands set aside in conservation easements might qualify for tax credits.

The overall unit cost of this practice is weighted to reflect program data indicate that at least 80% of the forest conservation acres come from retained forest acres on developed sites and less than 20% of acres are planted (MD DNR, 1999). Thus, the weighted average cost is $22/ac/yr.

2.2.4 Onsite Wastewater Management Systems

As shown in Exhibit 3, the denitrification BMP for onsite wastewater management systems (OSWMSs; also called onsite disposal systems, or OSDS) reduces the total nitrogen (TN) concentration of edge-of-field effluent to 10 mg/L. A variety of technologies are available to reduce nitrogen and other pollutants, but only two reduce TN sufficiently (according to the results of third-party field tests) to meet the 10 mg/L edge of field concentration. The two technologies are Amphidrome from F.R. Mahony and the MicroFAST system from BioMicrobics.

The Amphidrome process consists of a deep bed filter that alternates between aerobic and anoxic treatment, allowing for nitrification and denitrification in a single reactor. A cyclical action is created by allowing a batch of wastewater to pass from the anoxic tank through the filter into the clear well, and then reversing the flow through a pump. The cycles are repeated until the desired effluent quality is achieved. In a test by the Massachusetts Alternative Septic System Test Center (MASSTC, 2002), the Amphidrome process achieved average concentrations of 10.9 mg/L TN at the edge of the leaching trench soil absorption system (the soil absorption system is distinct from the drainage field; that is, the 10.9 mg/L TN is the concentration at the end of the technology train and more nitrogen may be removed in the drainage field). MicroFAST is a fixed film, aerated system utilizing a combination of attached and suspended growth. Microorganisms in the inner aerated media chamber digest nutrients in the wastewater. A test by the MASSTC shows average concentrations of 12.2 mg/L TN at the edge of the leaching field soil absorption system (MASSTC, 2001a).

In Tiers 1-3, denitrification is implemented for a percentage of new systems installed between 2001 and 2010 (0% in Tier 1, 10% in Tier 2, and 100% in Tier 3), and 1% of existing systems in Tier 3 (0% in Tiers 1 and 2). The 1% in Tier 3 represents failed systems and opportunities for upgrades (i.e., systems that would be replaced regardless of the tier requirements for end-of-pipe effluent concentrations). The cost for the BMP in new homes is not addressed here because the additional expense associated with denitrification would be included in the cost of a new home and can easily be offset by cost reductions in other materials or features in the new home. Similarly, the annual O&M costs described below are relatively small and could be easily offset by selecting lower maintenance materials or features elsewhere in the home such as lower maintenance exteriors or energy-saving appliances. The development of BMP costs for existing systems is described below.

For existing systems, the BMP cost is the cost of installing denitrification technology during a system upgrade or repair. **Exhibit 15** summarizes the costs for the two technologies. The MicroFAST treatment unit costs $3,200 (including installation, tax, and freight) for a 3-bedroom house with an average flow of 330 gpd, and electricity to operate the system would cost about $20 per month, according to a sales representative (personal communication with B. Ehrhart, Virginia DEQ, October 2002). A service contract including quarterly inspections would cost $300 per year, based on costs for Massachusetts (MASSTC, 2001a). Annualizing the $3,200 capital cost at 7.4% over 20 years results in an annualized capital cost of $312, and adding the O&M costs of $240 (electricity) and $300 (service contract) results in an annual cost of $852 per system. The Amphidrome unit costs $7,500 including installation, tax, and freight for a 3-bedroom house with an average flow of 330 gpd according to a sales representative (personal communication with B. Ehrhart, Virginia DEQ, November 2002). Electricity costs for the Amphidrome are estimated at $23 per year, based on information from the manufacturer (personal communication with P. Pedros, F.R. Mahony, November 2002). A service contract including quarterly inspections would cost about $300 per year according to the Massachusetts study (MASSTC, 2002). Annualizing the $7,500 capital cost at 7.4% over 20 years results in annualized capital costs of $730, and adding the annual O&M costs of $23 (electricity) and $300 (service contract) results in annual costs of $1,053 per system. Averaging the costs for the two technologies produces an annual average cost of $953.

This BMP also includes frequent pumping (i.e., every 3 years). The pumping costs are a mean value based on four sources: NSFC (1998), MASSTC (2001b), Austin City Connection (2001), and U.S. EPA (1999a). These sources report pumping costs that range from $124 to $268/system, with an average cost of $202/system. The cost for pumping every 3 years would be $67/system/yr (dividing the pumping cost by 3). Thus, the cost for denitrification combined with frequent pumping is $1,020/system/yr, of which $521 or 51% is annualized capital cost. This cost may exceed actual average costs for several reasons. First, it is based on a quarterly service contract, which is required by Massachusetts law for some onsite system permits but may not be required by laws in the basin states. Second, homeowners could potentially save costs by having the unit serviced or inspected at the same time as it is pumped out. Finally, regular pumping is already required for onsite system maintenance; therefore, this cost overestimates incremental O&M costs to current onsite system owners.

Exhibit 15: Onsite Wastewater Management System Denitrification BMP Costs[1]

Component	MicroFAST Cost	Amphidrome Cost	Average Cost
Treatment unit[1]	$3,200	$7,500	$5,350
Annualized capital cost ($/yr)[2]	$312	$730	$521
Electricity ($/yr)	$240	$23	$132
Service contract ($/yr)	$300	$300	$300
Holding tank pumping ($/yr)	$67	$67	$67
Total annual cost	$919	$1,120	$1,020

Sources: MASSTC (2001a, 2001b, 2002), NSFC (1998), Austin City Connection (2001), U.S. EPA (1999a). All costs are in 2001 dollars.
1. Includes installation, tax, and freight.
2. Annualized at 7.4% over 20 years.

In Section 3, costs for OSWMSs are reported as accruing to households. However, U.S. EPA (2002) identified several loan, cost-share, and other programs that can help homeowners pay for upgrades, including upgrades to reduce nutrient pollution:

1. The Clean Water State Revolving Funds (CWSRF), which traditionally provide low- and no-interest loans for upgrades at POTWs but which can also be used for installation, repair, and upgrade of OSWMS in small-town, rural, and suburban areas; the Hardship Grant Program of the CWSRF also provides grants for improving onsite treatment in low-income regions

2. The Nonpoint Source Pollution Program of the U.S. EPA OWOW provides cost-share for onsite system repairs and upgrades

3. The U.S. Department of Agriculture Rural Housing Service offers direct loans, loan guarantees, and grants to low- or moderate-income individuals to finance upgrades

4. State grants through the U.S. Department of Housing and Urban Development Community Block Grant Program can provide funds for improvements to OSWMSs, channeled through town or county government agencies

2.2.5 Summary of BMP Unit Costs

Exhibit 16 provides a summary of the annual unit costs for each of the agricultural, harvested forest land, urban land, and onsite system BMPs. The annual costs include annualized capital costs and annual O&M costs. The table also reports the initial capital cost per acre or system along with the assumptions used to annualize the capital cost (i.e., the annualization rate and time period).

Exhibit 16: Summary of Unit BMP Costs

BMP	Land Use[1]	Total Annual Cost[2]	Capital Cost[2]	Annualization Rate	Annualization Period (years)
Agriculture					
Forest Buffers	HT, LT, H, P	$108	$1,284	5%	25
Grass Buffers	HT, LT	$17	$132	5%	10
Wetland Restoration	HT, LT, H, P	$116	$1,221	5%	30
Retirement of Highly Erodible Land	HT, LT, H	$17	$132	5%	10
Tree Planting	HT, LT, P	$108	$1,284	5%	25
Farm Plans	HT, LT	$17	$92	5%	10
Farm Plans	H, P	$13	$69	5%	10
Cover Crops	HT, LT	$27	na	na	na
Stream Protection w/Fencing	P	$104	$578	5%	10
Stream Protection w/o Fencing	P	$75	$417	5%	10
Nutrient Management Plan Implementation	HT, LT, H	$7	$19	5%	3
Grazing Land Protection	P	$27	$150	5%	10
Animal Waste Management Systems	M	$8,186	$35,398	5%	10
Yield Reserve	HT, LT, H	$7	$19	5%	3
Carbon Sequestration	HT, LT	$13	$100	5%	10
Excess Manure Removal	M	$3.11	na	na	na
Conservation Tillage	HT	$2.72	na	na	na
Forestry					
Forest Harvesting Practices (Erosion Control)	F	$84	na	na	na
Urban					
Forest Buffers	PU, MO	$108	$1,284	5%	25
Grass Buffers	PU	$17	$132	5%	10
Low-Impact Development	PU, IU	$0	$0	5%	20
Storm Water Retrofits	PU	$330	$2,550	5%	20
Storm Water Retrofits	IU	$820	$6,336	5%	20
Storm Water Retrofits	UU	$1,930	$14,912	5%	20
Storm Water Management on New Development	PU	$150	$1,159	5%	20
Storm Water Management on New Development	IU	$450	$3,477	5%	20
Nutrient Management	PU	$2.06	$5.61	5%	3
Nutrient Management	MO	$0.52	$1.42	5%	3
Urban Land Conversion	PU, IU	$0	$0	5%	25
Forest Conservation	PU, IU	$22	$257	5%	25
Onsite Systems					
Denitrification w/ Pumping	na	$1,020	$5,350	7.4%	20

na = not applicable.

1. HT = High Till; LT = Low Till; H = Hay; P = Pasture; M = Manure acres (1 manure acre = 145 animal units); PU = Pervious Urban, IU = Impervious Urban; UU = Ultra-Urban; MO = Mixed Open; F = Forest.
2. Costs are in 2001 dollars per acre, except for excess manure removal ($/wet ton) and onsite system denitrification ($/system), and reflect the cost of the practice before offsets from federal and state cost share programs. For more information on practice costs, see written documentation.

Exhibit 17 provides state-level information on the agricultural BMP cost shares. It shows the variation in farmer costs by state and BMP. Farmer costs for most BMPs are lowest in Delaware, Maryland, New York, and Pennsylvania because these states have the largest cost-share percentages. Farmer costs tend to be highest in West Virginia because this state's programs have lower cost-share percentages for BMP installation costs than other basin states. Virginia has installation cost-share percentages similar to West Virginia, but has higher incentive payments for many BMPs.

2.2.6 Limitations and Uncertainties in the Analysis

The estimated costs above reflect a number of assumptions that may result in under- or overestimates of actual costs. **Exhibit 18** illustrates the sources of potential bias in the cost estimates, as well as the potential impact on costs (if known).

3. RESULTS

This section provides the resulting estimates of costs of the tier scenarios. The overview in Section 3.1 provides cost summaries at the watershed, state, sector, and state basin levels. The section also includes estimates of the potential distribution of total costs between the federal, state, and local sectors, although the actual incidence may differ. Section 3.2 provides estimates including federal and state contributions, and total facility-level costs for point sources, without incorporating expected grant funding available for municipal facilities.

3.1 Overview of Estimated Costs

This section provides a summary of total annual costs and total capital costs at the watershed, state, sector, and basin levels of aggregation. Total annual costs refer to the cumulative costs for each tier scenario. Cumulative cost reflects the total cost of implementing nutrient controls in a scenario, above the cost of the Progress 2000 scenario. Total annual costs include annualized capital costs for control technologies or BMPs that require initial capital expenditures and annual O&M expenditures.

Exhibit 19 shows total annual cumulative costs for each of the three tier scenarios. These estimates represent the annual costs at full implementation of all controls. Therefore, actual annual costs during the period that controls are gradually phased in will be lower.

Exhibit 19 also shows the average annual costs for each of the projected 6.3 million households by 2010, if all costs were paid by households living in the watershed. These annual costs are small compared to median household incomes in the watershed. The median estimate for the counties in the watershed is $49,300. This estimate is in 2001 dollars and reflects incomes in the 2000 Census of Population. Average median incomes across the states range from $37,800 for the watershed counties in New York to $58,300 for Maryland.

Exhibit 17: Comparison of Estimated Farmer and Federal/State Program Costs for Agricultural BMPs across States (2001 $/ac/yr)[1]

BMP	Total Practice Cost	Farmer Cost						Federal/State Cost-Share					
		DE	MD	NY	PA	VA	WV	DE	MD	NY	PA	VA	WV
Forest Buffers	108	23	(8)	23	11	28	34	85	116	85	97	80	74
Grass Buffers	17	(3)	(13)	(3)	(5)	(7)	(1)	20	30	20	22	24	18
Wetland Restoration	116	42	32	42	32	46	52	74	84	74	84	70	64
Retirement of HEL	17	(3)	(13)	(3)	(5)	(7)	(1)	20	30	20	22	24	18
Tree Planting	108	23	23	34	34	28	34	85	85	74	74	80	74
Farm Plans (Cropland)	17	7	7	7	5	8	8	10	10	10	12	9	9
Farm Plans (Hay and Pasture Land)	13	5	5	5	4	6	6	8	8	8	9	7	7
Cover Crops	27	7	7	3	12	7	7	20	20	24	15	20	20
Stream Protection with Fencing	104	48	38	38	29	48	48	56	66	66	75	56	56
Stream Protection without Fencing	75	35	28	28	32	35	35	41	47	47	43	41	41
Nutrient Management Plan Implementation	7	4	5	1	1	4	2	3	2	6	6	3	5
Grazing Land Protection	27	12	10	10	11	12	12	15	17	17	16	15	15
Animal Waste Management Systems	8,186	4,748	4,175	4,175	4,519	4,748	4,748	3,438	4,011	4,011	3,667	3,438	3,438
Yield Reserve	7	0	0	0	0	0	0	7	7	7	7	7	7
Carbon Sequestration	13	13	13	13	13	13	13	0	0	0	0	0	0
Excess Manure Removal	3.11	0.00	0.00	3.11	3.11	3.11	3.11	3.11	3.11	0.00	0.00	0.00	0.00
Conservation Tillage	2.72	2.72	2.72	2.72	2.72	2.72	2.72	0.00	0.00	0.00	0.00	0.00	0.00

Numbers in parentheses indicate net negative costs (i.e., a cost savings).

1. Total practice costs do not include land rental costs or opportunity costs of taking land out of production. State and federal costs include installation cost share, annual maintenance, and one-time incentive payments but do not include land rental payments.

Exhibit 18: Sources of Uncertainty in the BMP Cost Estimates

Source	Potential Impact on Costs	Comments
The extent to which the tier scenarios overlap with other requirements for which costs will be incurred anyway (e.g., under the CAFO rule or CZARA) is unknown.	+	Including costs to implement the forthcoming CAFO regulations and state CZARA programs overstates the costs attributable to the tier scenarios.
Tax credits are not incorporated into farmer portion of agricultural BMP costs.	+[1]	Net farmer cost would be lower for producers claiming a tax credit for implementing BMPs.
Land rental payments assumed to offset revenue loss to farmers.	+	To the extent that rental payments exceed the net revenue loss associated with practices that involve converting land out of agricultural production, farmer costs are overestimated .
Annualized capital costs based on a finance or contract period rather than the useful life of equipment or material.	+	Annual costs will overstate actual costs when the equipment or material is still generating nutrient control benefits beyond the finance or contract period.
The average BMP unit cost estimates may have small overlaps with other BMP costs and, therefore, double-count costs.	+	Most unit BMP cost estimates correct for known practice overlaps, but there may be overlaps that are not accounted for and, therefore, costs are double-counted. For example, the unit cost estimate for streambank protection BMP includes an unknown amount of forest buffer costs, and the unit cost estimate for grazing land protection BMP includes an unknown amount of streambank protection costs.
Storm water retrofits do not include cost savings of "piggy back" opportunities.	+	Municipalities can realize substantial cost savings if retrofit projects can be implemented during planned maintenance, repair, or redevelopment activities.
All OSWMS denitrification costs apportioned to homeowners.	+[1]	Several grant and low-interest loan programs are available and would reduce the household share of the costs of OSWMS upgrades.
Annualized capital costs are based on assumed financing rates.	?	Actual financing rates may differ from sector- or state-specific rates.
Constant unit BMP costs applied to all BMP acres in the Basin.	?	Actual BMP costs will vary from site to site.

+ = assumption results in overestimating costs
? = impact of assumption on cost estimates is unknown
1. Sign shown reflects an impact on direct farmer or household costs; the impact on total costs is zero since this assumption affects only the distribution of costs.

Exhibit 19: Total Annual Cumulative Costs (millions of 2001$)

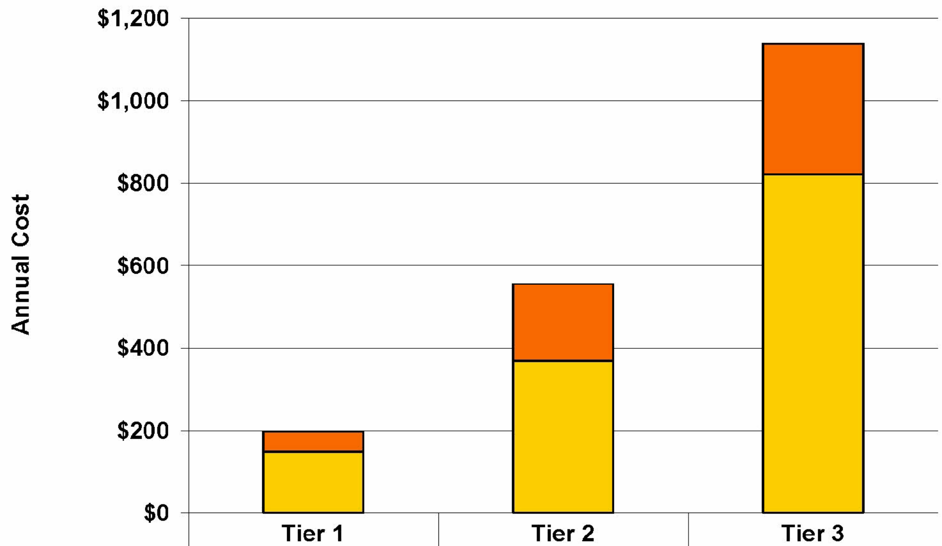
Cost Category	Tier 1 (cost of current programs funded to 2010)[1]	Tier 2 (Tier 1 + Tier 2)	Tier 3 (Tier 1+ Tier 2 + Tier 3)
Total Annual Costs ($millions)[2]	$198	$555	$1,139
Implied Cost per Household (before cost-share)[3] ($)	$31	$88	$181
Share of Watershed Median Household Income ($49,300)	0.1%	0.2%	0.4%

1. Tier 1 costs do not include POTW NRT projects that have already been completed or funded.
2. Includes costs paid by federal and state cost-share programs.
3. Actual household costs will vary by location and type of household (e.g., urban or farm) and will be reduced by the federal and state funding shares. The impact analysis addresses these distributional effects.

The average cost for households in the watershed will be lower than the estimates shown in Exhibit 19 because federal and state cost-share programs provide financial support for nutrient controls. **Exhibit 20** illustrates the estimated breakdown between local costs and federal/state costs based on the cost-share assumptions described previously. Those assumptions use current cost-share information for the agricultural sector, and state estimates for the POTW sector, to project future funding. Actual cost-share amounts may differ. There are no estimates of cost shares for urban BMPs. Nevertheless, retrofit BMPs applied to developed areas may receive substantial support from federal and state sources. Furthermore, there may be "piggy back" opportunities that reduce incremental retrofit BMP costs to a fraction of the unit costs shown above because BMPs can be cost-effectively integrated into planned infrastructure upgrades, repairs, or investments.

Federal and state programs for agricultural and POTW controls could provide $49 million of annual Tier 1 costs (or 25%), $186 million of annual Tier 2 costs (or 33%), and $317 million of annual Tier 3 costs (or 28%). The total cost-share contribution increases from Tier 1 to Tier 2 because agricultural costs increase relative to other sectors, and most costs in that sector are covered by cost-share programs. The total cost-share contribution declines from Tier 2 to Tier 3 as urban costs increasingly dominate total costs.

Total capital costs that correspond to the annual costs reported in Exhibit 19 are $1.4 billion for Tier 1, $3.6 billion for Tier 2, and $8.0 billion for Tier 3. These estimates include anticipated federal and state cost shares. These costs will be incurred slowly over time as controls are gradually implemented. Nevertheless, comparing them to annual economic statistics provides crucial perspective because–despite their magnitude–they are small compared to total annual personal income, which in 1999 was $574 billion ($610 billion in 2001 dollars) in the watershed counties and $1.4 trillion ($1.5 trillion in 2001 dollars) in the basin states and the District of Columbia (BEA, 2001).



	Tier 1	Tier 2	Tier 3
Total	$198	$555	$1,139
Fed./State	$49	$186	$317
Local	$149	$369	$821

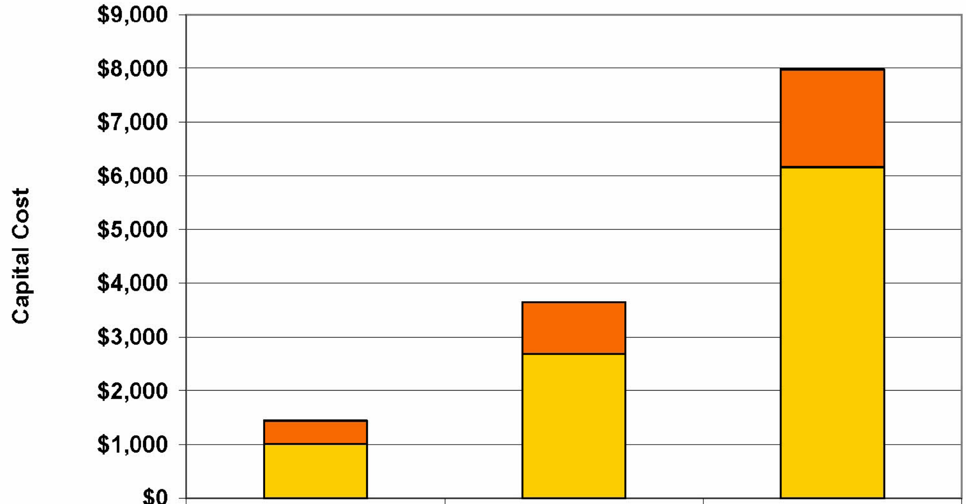
Exhibit 20: Estimated Distribution of Annual Costs (millions of 2001$)

Exhibit 21 shows the share of capital costs estimated for federal and state programs and the remainder estimated for private businesses and households in the watershed. These shares are based on the cost-share program funding levels described in the POTW and agricultural BMP cost sections. Actual cost-share amounts may differ. The percent of total capital costs paid through cost-share programs in Exhibit 21 is approximately the same as the percent of total annual costs in Exhibit 20.

3.1.1 Cost Distribution by State

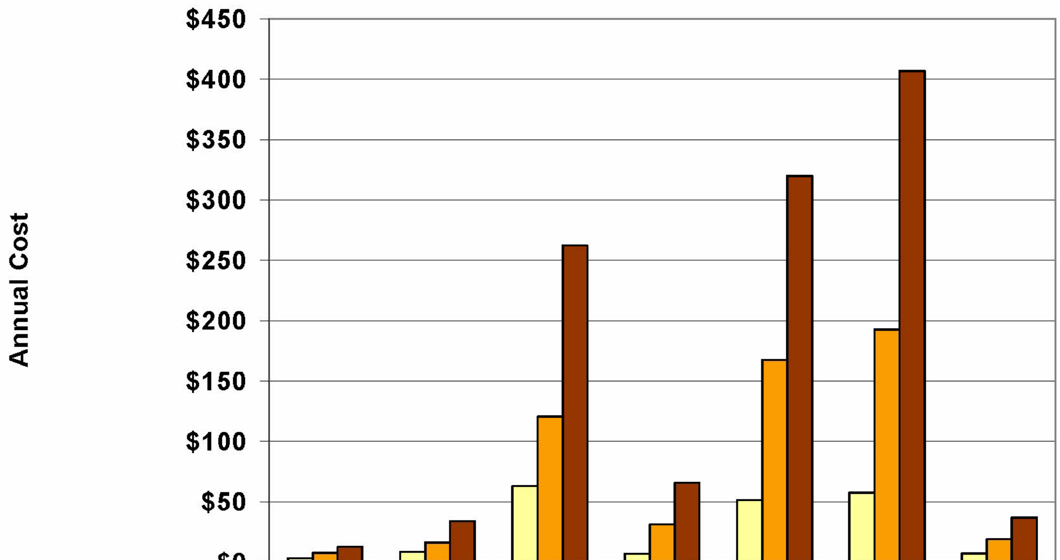
A breakdown of annual costs by state (**Exhibit 22**) shows that three states–Maryland, Pennsylvania, and Virginia–account for almost 90% of costs across all three tier scenarios. Maryland has the largest share of annual Tier 1 costs, followed by Virginia and Pennsylvania. However, Virginia has the highest share of Tier 2 and Tier 3 costs, followed by Pennsylvania and Maryland. Maryland's shift from highest baseline (i.e., Tier 1) costs to third highest Tier 2 and Tier 3 costs signifies its high baseline implementation commitment. (Note, however, that Tier 1 costs do not completely reflect this commitment since they do not include the cost of NRT upgrades at POTWs that have already been funded or completed.)

The cumulative cost estimates shown in Exhibit 22 do not reflect the incremental costs of implementing controls beyond current implementation levels. The incremental costs for Tiers 2 and 3 can be derived by subtracting the Tier 1 costs from the cumulative Tier 2 and 3 costs, respectively. For example, the annual incremental cost of Tier 2 is $357 million ($555 million minus $198 million).



	Tier 1	Tier 2	Tier 3
Total	$1,442	$3,644	$7,975
Fed./State	$433	$957	$1,815
Local	$1,009	$2,686	$6,161

Exhibit 21: Estimated Distribution of Capital Costs (millions of 2001$)

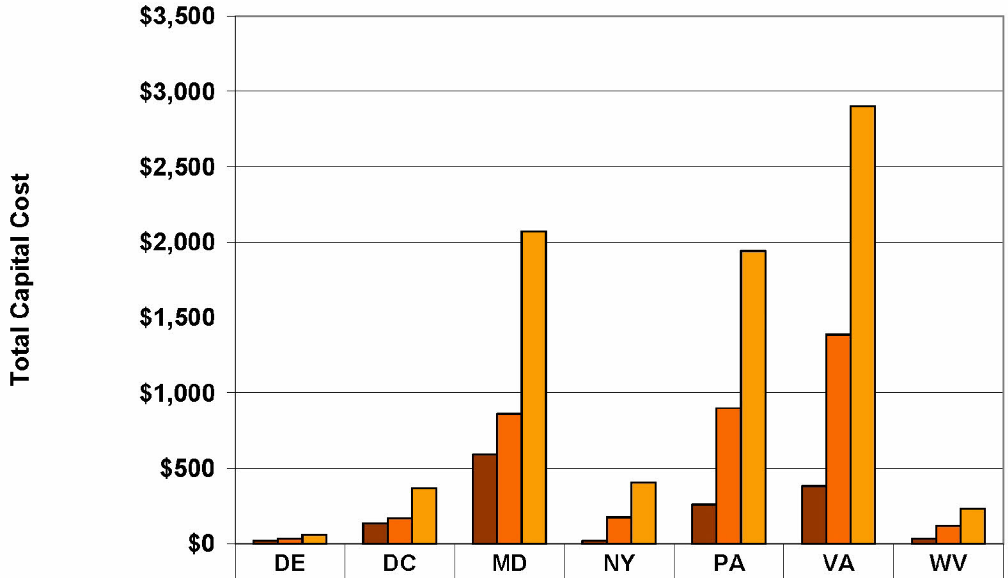


	DE	DC	MD	NY	PA	VA	WV
Tier 1 ($198)	$3	$9	$63	$7	$51	$57	$7
Tier 2 ($555)	$8	$16	$121	$31	$167	$192	$19
Tier 3 ($1,139)	$13	$34	$262	$66	$320	$407	$37

Exhibit 22: Total Annual Cumulative Costs by State and Tier (millions of 2001$)

Note: Costs for Blue Plains WWTF are apportioned to DC, MD and VA according to the method recommended by MWCOG (2002).

The distribution of capital costs across the states (**Exhibit 23**) follows the same pattern as annual costs in Exhibit 22. Maryland, Pennsylvania, and Virginia account for almost 90% of watershed costs across all tier scenarios. Maryland costs are highest in Tier 1, followed by Virginia and Pennsylvania. Tier 2 and Tier 3 capital costs in Virginia are highest, followed by Maryland and Pennsylvania. These costs include the portion that will be funded through federal and state cost-share programs as well as costs that will be paid by businesses and households in the watershed. Similar to annual costs, they are the cumulative costs of implementing each tier scenario.



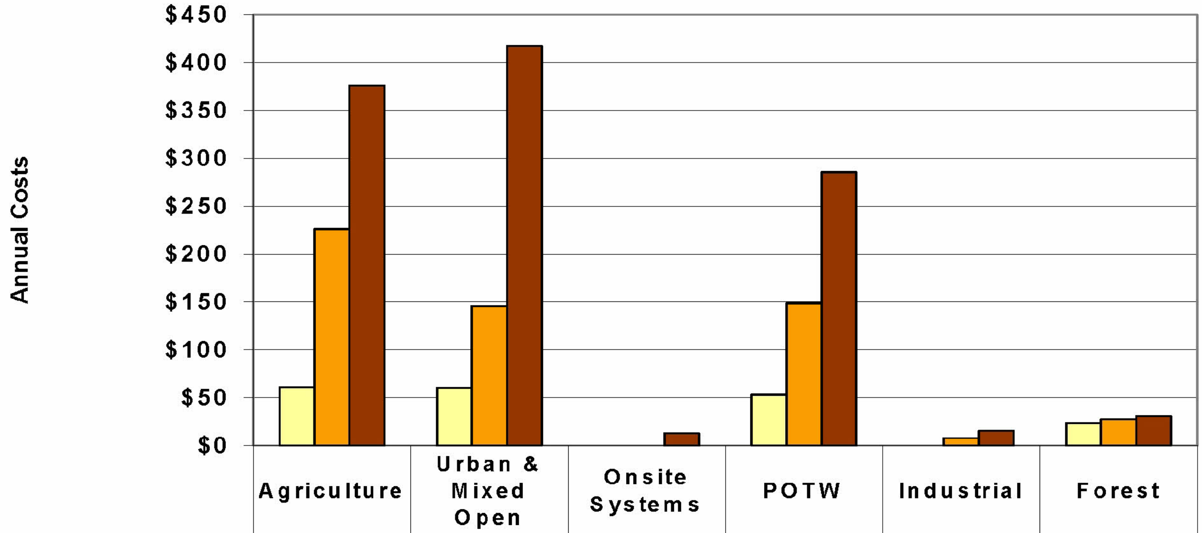
	DE	DC	MD	NY	PA	VA	WV
Tier 1 ($1,442)	$21	$133	$592	$20	$258	$382	$35
Tier 2 ($3,644)	$36	$170	$860	$175	$899	$1,387	$116
Tier 3 ($7,975)	$60	$368	$2,069	$405	$1,940	$2,901	$232

Exhibit 23: Total Cumulative Capital Costs by State and Tier (millions of 2001$)

Note: Costs for Blue Plains WWTF are apportioned to DC, MD and VA according to the method recommended by MWCOG (2002).

3.1.2 Cost Distribution by Sector

In **Exhibit 24**, annual costs by sector (aggregated across states) show that the agriculture, POTW, and urban (plus mixed open) sectors account for the vast majority of costs across all tiers. The agriculture and urban sectors account for the highest share of Tier 1 costs, followed by POTW costs. In Tier 2, agricultural costs dominate total costs (41%) followed by POTW costs (27%) and urban costs (26%), but the urban sector contributes the highest share of costs in Tier 3 (37%) followed by agricultural costs (33%). Growth in agricultural costs is relatively steady–increasing by approximately $165 million from Tier 1 to Tier 2 and by $150 million from Tier 2 to Tier 3. In contrast, POTW and urban costs experience a larger increase between Tiers 2 and 3. For urban costs, the greater increase from Tier 2 to Tier 3 compared to the increase from Tier 1 to Tier 2 is attributable to the increase in implementation of storm water retrofits.

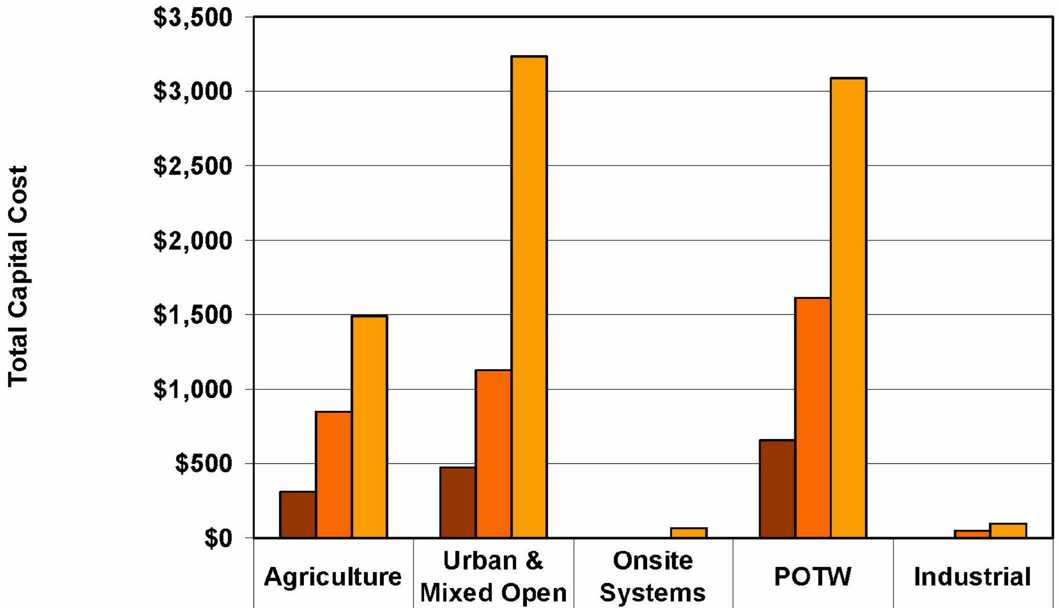


	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Forest
Tier 1 ($198)	$61	$60	$0	$53	$0	$23
Tier 2 ($555)	$226	$146	$0	$148	$8	$27
Tier 3 ($1,139)	$376	$418	$13	$286	$15	$31

Exhibit 24: Total Annual Cumulative Costs by Sector and Tier (millions of 2001$)

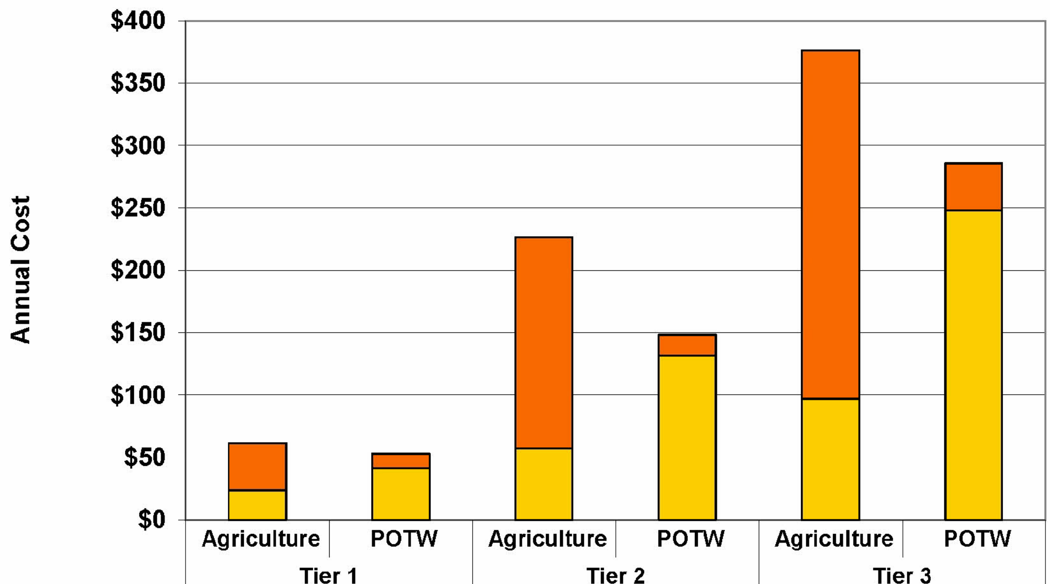
Exhibit 25 shows the breakdown of total capital costs by sector. The distribution of capital costs across sectors differs somewhat from the annual cost distribution. POTW costs account for the largest share of capital costs in Tiers 1 and 2 (45% in Tier 1 and 44% in Tier 2), followed by urban and agricultural costs. In Tier 3, urban costs account for the largest share (41%) followed by POTW and agricultural costs.

Exhibit 26 provides a comparison of estimated federal/state and local (i.e., farmer or household) annual costs for the POTW and agricultural sectors, under the cost-share assumptions described previously. The height of each bar shows the total annual cost for each of the two sectors. Each bar also shows the estimated distribution of costs between federal and state cost share programs and private farm businesses (in the case of agricultural costs) or local households (in the case of POTW costs). In the agricultural sector, federal and state cost share programs contribute a majority of the total costs for each tier (61% in Tier 1, 75% in Tier 2, and 74% in Tier 3). In the POTW sector, estimated federal and state cost sharing is lower (22% in Tier 1, 11% in Tier 2, and 13% in Tier 3) because cost sharing is only applied to facilities serving populations in Maryland and Virginia. The estimated federal and state contribution is higher in Tier 1 because the largest share of annual costs for POTWs is for facilities serving populations in Maryland, and a greater proportion of costs are shared for Maryland POTWs. In Tiers 2 and 3, a larger share of POTW costs are for facilities serving populations in other states and the District of Columbia.



	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial
Tier 1 ($1,442)	$312	$475	$0	$655	$0
Tier 2 ($3,644)	$850	$1,128	$0	$1,615	$51
Tier 3 ($7,975)	$1,490	$3,233	$68	$3,087	$98

Exhibit 25: Total Cumulative Capital Costs by Sector and Tier (millions of 2001$)



	Tier 1		Tier 2		Tier 3	
	Agriculture	POTW	Agriculture	POTW	Agriculture	POTW
Total	$61	$53	$226	$148	$376	$286
Fed./State	$38	$12	$169	$17	$279	$38
Local	$24	$41	$57	$132	$97	$248

Exhibit 26: Estimated Distribution of Annual Costs for Agriculture and POTW Sectors (millions of 2001$)

3.1.3 Cost Distribution by State and Sector

This section provides the state-level cost breakdowns for each sector. Similar to earlier sections, the annual and capital cost estimates represent cumulative costs for each tier scenario and include both state and federal cost-share amounts as well as estimated costs for private businesses and households.

3.1.3.1 POTW and Industrial Source Costs

Costs for nutrient reduction technologies among POTW and industrial sources include capital expenditures and annual O&M costs. There are no industrial control costs in Tier 1. Tiers 2 and 3 include industrial controls, but POTW control costs account for more than 90% of annual costs. Total annual costs of $156 million for Tier 2 include $148 million for POTWs and $8 million for industrial facilities. Similarly, annual Tier 3 costs of $301 million include $286 million for POTWs and $15 million for industrial facilities.

Exhibit 27 shows the breakdown of POTW costs by state. These results show the largest share of Tier 1 costs occur in Maryland, and the largest share of Tier 2 and Tier 3 costs occur in Virginia and Pennsylvania. These results show how planned (Tier 1) NRT implementation costs vary across these states. Maryland is planning expenditures of $29.5 million annually under Tier 1, which accounts for 81% of cumulative costs under Tier 2 and 35% of cumulative costs under Tier 3. In contrast, Pennsylvania's Tier 1 costs are $6.5 million, which accounts for 20% of cumulative Tier 2 costs and 11% of cumulative Tier 3 costs. Virginia's Tier 1 costs are $8.7 million, which equals 15% of cumulative Tier 2 costs and 9% of Tier 3 costs.

Exhibit 27: Summary of Total Cumulative Annual and Capital POTW Costs[1] (millions of 2001 dollars)

	Annual Costs			Capital Costs		
Jurisdiction	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Delaware	$0.2	$0.6	$0.8	$3.2	$5.8	$9.0
District of Columbia	$8.3	$14.1	$25.7	$130.0	$154.3	$303.5
Maryland	$29.5	$36.2	$85.2	$356.0	$393.0	$981.6
New York	$0.0	$6.2	$10.2	$0.0	$65.2	$105.8
Pennsylvania	$6.5	$31.8	$60.0	$72.1	$352.0	$670.7
Virginia	$8.7	$57.9	$101.3	$93.9	$623.6	$984.8
West Virginia	$0.0	$1.7	$2.4	$0.0	$21.3	$31.5
Total	$53.1	$148.3	$285.5	$655.2	$1,615.1	$3,086.9

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are apportioned to DC, MD, and VA according to the method recommended by MWCOG (2002).

1. Includes federal and state cost shares equal to 10% of capital costs for VA, 50% of capital costs for MD, and 0% for remaining jurisdictions.

Total capital costs for POTWs and industrial dischargers are $0.7 billion for Tier 1, $1.7 billion for Tier 2, and $3.2 billion for Tier 3. This includes costs paid by households in the watershed as well as costs paid by federal and state cost-share programs. Similar to annual costs, POTW accounts for more than 90% of these costs in each tier. The distribution of POTW capital costs across states, shown in Exhibit 27, mimics the distribution of annual costs.

3.1.3.2 Agriculture Costs

The total annual costs in **Exhibit 28** include those paid by farmers and those paid by cost-share programs. Based on current implementation shares, the cost-share programs would account for approximately 75% of annual costs in Tiers 2 and 3; farmers would incur the remaining 25% of annual costs. Cost-share programs account for a smaller share of annual Tier 1 costs (60%) because BMPs with lower cost-shares such as animal waste management systems account for a larger portion of annual costs.

Exhibit 28: Summary of Total Cumulative Annual and Capital Agricultural Costs[1] (millions of 2001 dollars)

	Annual Cost			Capital Cost		
Jurisdiction	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Delaware	$2.2	$6.3	$9.4	$14.4	$22.3	$31.6
District of Columbia	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Maryland	$8.3	$33.8	$49.6	$49.6	$88.9	$128.3
New York	$1.8	$14.7	$28.3	$7.5	$61.9	$127.5
Pennsylvania	$22.2	$90.9	$146.6	$110.7	$313.5	$527.6
Virginia	$21.6	$67.8	$118.3	$102.1	$293.1	$539.6
West Virginia	$5.1	$12.7	$24.2	$27.9	$70.6	$135.2
Total	$61.3	$226.3	$376.3	$312.2	$850.4	$1,489.9

Detail may not add to total because of independent rounding.

1. Based on current cost share program information, federal and state cost-share programs would account for approximately 60% of annual costs in Tier 1 and 75% of costs in Tiers 2 and 3.

Annual costs are highest in Pennsylvania for all tier scenarios. Virginia has the second highest share of costs in all scenarios, followed by Maryland. Together, Pennsylvania and Virginia account for 70% of annual agricultural costs.

Total capital costs in the agricultural sector are $312 million for Tier 1, $850 million for Tier 2, and $1.5 billion for Tier 3. The distribution of capital costs across states (Exhibit 28) is similar to the annual cost distribution.

3.1.3.3 Forestry Costs

Annual costs to implement forest harvesting best management practices range from $23.5 million in Tier 1 to $30.8 million in Tier 3. Thus, baseline implementation in Tier 1 accounts for most of the costs in this sector. **Exhibit 29** provides annual cost estimates by tier scenario. This sector has the smallest share of annual costs in all tier scenarios because implementation acre estimates are small. All costs are annual because practices are assumed to be implemented on different harvest acres each year.

Exhibit 29: Summary of Cumulative Annual Forest Harvest Costs (millions of 2001 dollars)

Jurisdiction	Tier 1	Tier 2	Tier 3
Delaware	<$0.1	<$0.1	$0.1
District of Columbia	$0.0	$0.0	$0.0
Maryland	$1.6	$1.8	$2.0
New York	$3.6	$4.1	$4.5
Pennsylvania	$13.9	$15.6	$17.4
Virginia	$3.0	$4.1	$5.1
West Virginia	$1.3	$1.5	$1.7
Total	$23.5	$27.1	$30.8

Detail may not equal total because of independent rounding.

3.1.3.4 Urban BMP Costs

Exhibit 30 provides annual costs by tier and jurisdiction for urban areas. These costs are for stormwater BMPs and exclude POTW costs. Tier 1 costs are highest in Maryland and Virginia, with each accounting for 40% of annual Tier 1 costs. Maryland's share of costs declines in Tier 2 (32%) and Tier 3 (29%) while shares for other states, except Delaware, increase across the scenarios. This is indicative of Maryland's higher baseline BMP implementation rate compared to most other states. Virginia's share of total annual costs is 41% for Tiers 2 and 3. Pennsylvania's share of total annual costs increases from 15% in Tier 1 to 21% in Tier 3.

Stormwater retrofits account for over 90% of annual urban costs in all tier scenarios. Although the total number of retrofit acres is small (e.g., less than 0.4% of watershed acres in Tier 2 and 1.8% in Tier 3), the per-acre cost is high compared to other sectors. Nevertheless, the average cost per household for the 4.9 million urban households in the watershed by 2010 is expected to be small, ranging from $12 in Tier 1 to $85 in Tier 3. These estimates assume that all costs are borne by urban households. However, federal and state cost share funds or other cost-saving opportunities might reduce these costs.

Total capital costs are $0.5 billion for Tier 1, $1.1 billion for Tier 2 and $3.2 billion for Tier 3. Exhibit 30 shows that the distribution of capital costs across states is similar to the distribution of annual costs.

Exhibit 30: Summary of Cumulative Annual Urban Costs (millions of 2001 dollars)

Jurisdiction	Annual Cost			Capital Cost		
	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Delaware	$0.5	$1.0	$2.4	$3.6	$7.4	$18.3
District of Columbia	$0.3	$2.1	$8.3	$2.6	$16.1	$64.4
Maryland	$23.8	$47.3	$119.5	$186.3	$365.7	$924.1
New York	$1.7	$6.4	$21.6	$13.0	$48.4	$165.8
Pennsylvania	$8.8	$27.0	$87.7	$75.7	$215.1	$684.7
Virginia	$24.1	$59.3	$170.5	$186.4	$455.7	$1,317.6
West Virginia	$0.9	$2.5	$7.5	$6.8	$19.1	$57.8
Total	$60.2	$145.5	$417.6	$474.5	$1,127.6	$3,232.7

Detail may not add to total because of independent rounding.

3.1.3.5 Onsite Waste Management System Costs

OSWMS costs for Tiers 1 and 2 are zero, and costs are minimal for Tier 3 because only 1% of existing systems implement the control. The annual cost for Tier 3 is $13 million and total capital costs equal $68 million. Maryland, Pennsylvania, and Virginia account for most of the costs in the sector. The average annual cost per household implementing the BMP is $1,020.

The cost for new homes is not included because it will be rolled up in the overall cost of a home, and developers have an opportunity to offset incremental OSWMS costs with savings in other construction costs. Furthermore, new homes built in developments can use multi-home systems with lower average per-home costs. The cost for new homes implied by the single system annual unit cost is $8 million in Tier 2 and $82 million in Tier 3.

3.1.3.6 Summary

Exhibit 31 summarizes the annual cost breakdowns by state and sector. The height of each bar shows the magnitude of total annual costs for each state and tier scenario. The height of sections within each bar shows the distribution of costs among the sectors for individual states and tiers. Exhibit 31 is similar to Exhibit 22, but it also shows the relative importance of each sector within state-level costs. For example, the POTW and urban sectors dominate costs for the District of Columbia; onsite system costs are very small in comparison (and agricultural, industrial, and forestry costs are zero). Agricultural costs tend to contribute the largest portion of costs in Delaware, Pennsylvania, and West Virginia. Conversely, POTW and urban sector costs tend to dominate annual costs in Maryland and Virginia. In New York, agricultural sector costs tend to be approximately equal to the sum of POTW and urban sector costs.

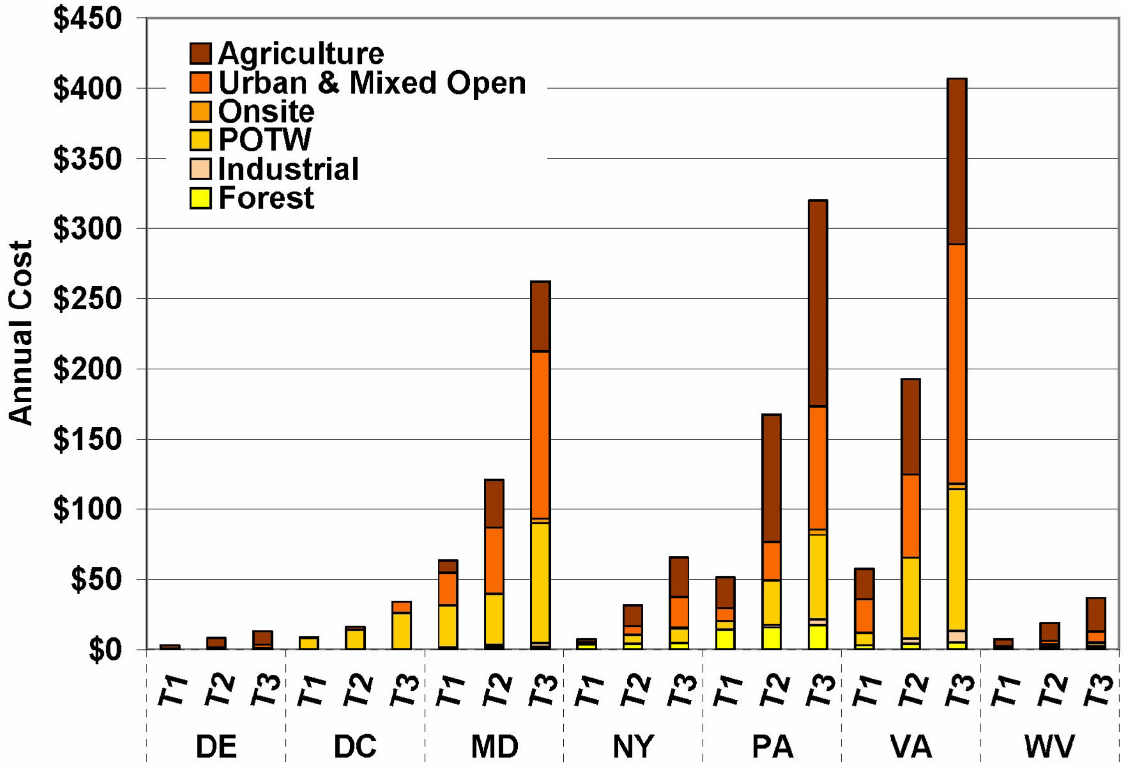


Exhibit 31: Total Annual Costs by State, Sector, and Tier (millions of 2001$)

Note: Costs for the Blue Plains WWTF are apportioned to DC, MD and VA according to the method recommended by MWCOG (2002).

Exhibit 31 also shows the relative importance of each state within sector-level costs. For example, among all the states and the District of Columbia, Pennsylvania has the highest share of agricultural and forestry costs, while urban and POTW costs are highest in Maryland and Virginia.

Within each state, the exhibit also shows which sectors contribute most to the increase in costs across the tier scenarios. For example, in Delaware and West Virginia, growth in agricultural costs dominates increases in overall costs from Tier 1 to Tier 3. In New York and Pennsylvania, growth in agricultural and urban costs contribute most to cost increases across the tier scenarios. Three sectors–agriculture, urban, and POTW–contribute roughly evenly to growth in costs for Maryland and Virginia.

A similar summary for capital costs is in **Exhibit 32**. The main difference between this chart and Exhibit 31 is that the agricultural sector's share of capital costs is much smaller. Therefore, urban and POTW capital costs tend to dominate most cost distributions. Finally, the forestry sector is not included in Exhibit 32 because there are no capital costs for that sector.

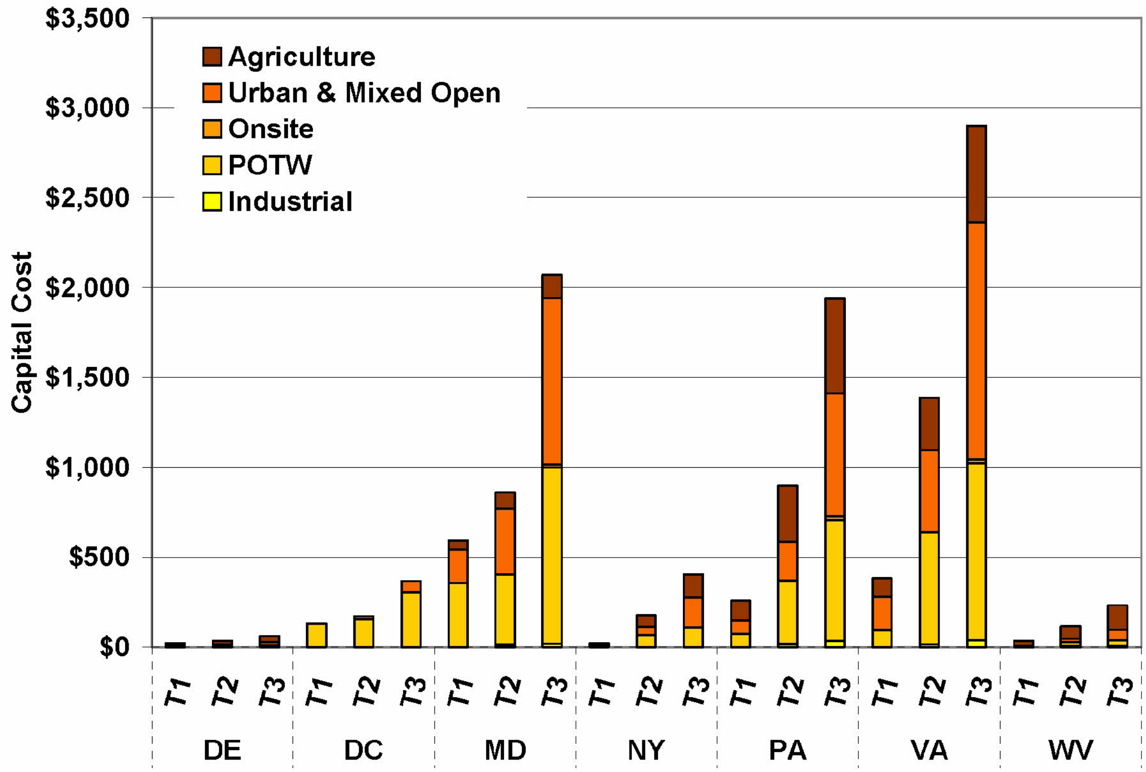


Exhibit 32: Total Capital Costs by State, Sector, and Tier (millions of 2001$)

Note: Costs for the Blue Plains WWTF are apportioned to DC, MD, and VA according to the method recommended by MWCOG (2002)

3.1.4 Cost Distribution by State Basin

An annual cost summary by state basin (**Exhibits 33** through **35**) provides location as well as sector detail within each state.

For Tier 1, the Susquehanna and Potomac Basins each account for approximately 30% of total annual costs, which include state and federal cost shares as well as costs to private businesses and households. The Maryland West Shore accounts for 12% of total annual costs, while the James Basin accounts for 11% of total annual costs; the remaining watersheds incur 8% or less of total annual costs. The agricultural and forestry sectors dominate Tier 1 costs in the Susquehanna Basin, while agricultural and urban sector costs are highest in the Potomac Basin.

Exhibit 33: Annual Costs by State Basin for Tier 1 (millions of 2001 $)

Statebasin	Agriculture	Urban and Mixed Open	Onsite Systems	POTW	Industrial	Forest	Subtotal	Federal/ State – Agriculture[1]	Federal/ State – POTW[2]
MD-Susquehanna	0.01	0.84	0.00	0.00	0.00	0.04	0.89	0.18	0.00
NY-Susquehanna	0.62	1.68	0.00	0.00	0.00	3.64	5.94	1.19	0.00
PA-Susquehanna	8.38	8.30	0.00	5.95	0.00	12.97	35.60	11.75	0.00
Susquehanna	9.01	10.82	0.00	5.95	0.00	16.64	42.43	13.12	0
DC-Potomac	0.00	0.33	0.00	8.26	0.00	0.00	8.59	0.00	0.00
MD-Potomac	1.55	9.07	0.00	3.21	0.00	0.51	14.34	3.47	1.98
PA-Potomac	0.73	0.50	0.00	0.54	0.00	0.89	2.66	1.30	0.00
VA-Potomac	4.83	9.20	0.00	1.54	0.00	-0.35	15.22	4.93	0.13
WV-Potomac	2.38	0.89	0.00	0.00	0.00	1.32	4.58	2.71	0.00
Potomac	9.48	19.99	0.00	13.54	0.00	2.38	45.39	12.41	2.11
MD-W. Shore MD	0.01	6.24	0.00	10.71	0.00	0.15	17.12	0.44	6.48
PA-W. Shore MD	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
W. Shore MD	0.02	6.24	0.00	10.71	0.00	0.15	17.13	0.45	6.48
DE-E. Shore MD	0.71	0.48	0.00	0.24	0.00	0.01	1.44	1.54	0.00
MD-E. Shore MD	-0.11	2.47	0.00	4.46	0.00	0.79	7.61	2.77	2.63
PA-E. Shore MD	0.03	0.01	0.00	0.00	0.00	0.01	0.06	0.05	0.00
VA-E. Shore MD	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00
E. Shore MD	0.66	2.97	0.00	4.70	0.00	0.82	9.14	4.38	2.63
MD-Patuxent	-0.11	5.18	0.00	0.00	0.00	0.10	5.17	0.05	0.00
Patuxent	-0.11	5.18	0.00	0.00	0.00	0.10	5.17	0.05	0.00

Exhibit 33: Annual Costs by State Basin for Tier 1 (millions of 2001 $)

Statebasin	Agriculture	Urban and Mixed Open	Onsite Systems	POTW	Industrial	Forest	Subtotal	Federal/ State – Agriculture[1]	Federal/ State – POTW[2]
VA-Rappahannock	1.04	1.82	0.00	1.07	0.00	0.45	4.38	1.73	0.09
Rappahannock	1.04	1.82	0.00	1.07	0.00	0.45	4.38	1.73	0.09
VA-York	0.83	1.90	0.00	1.76	0.00	1.19	5.67	1.78	0.17
York	0.83	1.90	0.00	1.76	0.00	1.19	5.67	1.78	0.17
VA-James	2.48	11.17	0.00	3.60	0.00	1.74	18.99	3.39	0.29
WV-James	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.00
James	2.49	11.17	0.00	3.60	0.00	1.75	19.01	3.41	0.29
VA-E. Shore VA	0.23	0.05	0.00	0.00	0.00	-0.01	0.27	0.29	0.00
E. Shore VA	0.23	0.05	0.00	0.00	0.00	-0.01	0.27	0.29	0.00
Total	**23.64**	**60.15**	**0.00**	**41.34**	**0.00**	**23.47**	**148.60**	**37.61**	**11.78**

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

1. Includes several programs for installation and other cost-sharing.
2. POTW capital costs are shared at 50% for MD facilities, at 10% for VA facilities, and at zero for other states and the District of Columbia.

Exhibit 34: Annual Costs by State Basin for Tier 2 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Forest	Subtotal	Federal/ State - Agriculture[1]	Federal/ State - POTW[2]
MD-Susquehanna	0.04	1.04	0.00	0.00	0.00	0.04	1.12	1.05	0.00
NY-Susquehanna	3.71	6.36	0.00	6.24	0.00	4.09	20.39	10.96	0.00
PA-Susquehanna	20.39	25.52	0.00	30.19	2.04	14.59	92.73	60.82	0.00
Susquehanna	24.13	32.91	0.00	36.42	2.04	18.73	114.23	72.84	0.00
DC-Potomac	0.00	2.10	0.00	14.07	0.00	0.00	16.17	0.00	0.00
MD-Potomac	1.80	17.70	0.00	7.91	0.83	0.57	28.82	10.87	2.79
PA-Potomac	2.24	1.44	0.00	1.60	0.00	1.00	6.28	6.87	0.00
VA-Potomac	9.10	22.82	0.00	8.12	1.04	-0.22	40.86	14.85	0.51
WV-Potomac	5.01	2.50	0.00	1.67	0.56	1.48	11.22	7.64	0.00
Potomac	18.15	46.56	0.00	33.37	2.43	2.84	103.35	40.23	3.31
MD-W. Shore MD	0.13	14.68	0.00	11.21	0.00	0.17	26.18	2.66	6.80
PA-W. Shore MD	0.02	0.01	0.00	0.00	0.00	0.00	0.03	0.07	0.00
W. Shore MD	0.15	14.68	0.00	11.21	0.00	0.17	26.21	2.73	6.80
DE-E. Shore MD	1.43	0.99	0.00	0.55	0.00	0.04	3.01	4.91	0.00
MD-E. Shore MD	0.08	4.90	0.00	4.78	0.00	0.89	10.65	16.35	2.68
PA-E. Shore MD	0.12	0.07	0.00	0.00	0.00	0.02	0.20	0.41	0.00
VA-E. Shore MD	0.05	0.01	0.00	0.00	0.00	0.00	0.06	0.16	0.00
E. Shore MD	1.67	5.98	0.00	5.34	0.00	0.95	13.93	21.82	2.68
MD-Patuxent	-0.09	8.96	0.00	0.01	0.81	0.12	9.81	0.90	0.00
Patuxent	-0.09	8.96	0.00	0.01	0.81	0.12	9.81	0.90	0.00

Exhibit 34: Annual Costs by State Basin for Tier 2 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Forest	Subtotal	Federal/ State - Agriculture[1]	Federal/ State - POTW[2]
VA-Rappahannock	2.94	4.02	0.00	2.72	0.00	0.59	10.26	7.28	0.22
Rappahannock	2.94	4.02	0.00	2.72	0.00	0.59	10.26	7.28	0.22
VA-York	1.97	4.24	0.00	3.02	0.04	1.43	10.69	5.68	0.26
York	1.97	4.24	0.00	3.02	0.04	1.43	10.69	5.68	0.26
VA-James	7.98	27.91	0.00	38.87	2.18	2.29	79.23	15.45	3.50
WV-James	0.03	0.00	0.00	0.00	0.00	0.01	0.05	0.05	0.00
James	8.01	27.91	0.00	38.87	2.18	2.30	79.28	15.5	3.50
VA-E. Shore VA	0.41	0.26	0.00	0.59	0.15	-0.01	1.41	2.01	0.05
E. Shore VA	0.41	0.26	0.00	0.59	0.15	-0.01	1.41	2.01	0.05
Total	**57.34**	**145.52**	**0.00**	**131.54**	**7.65**	**27.11**	**369.17**	**168.98**	**16.81**

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).
1. Includes several programs for installation and other cost-sharing.
2. POTW capital costs are shared at 50% for MD facilities, at 10% for VA facilities, and at zero for other states and the District of Columbia.

Exhibit 35: Annual Costs by State Basin for Tier 3 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Forest	Subtotal	Federal/ State - Agriculture[1]	Federal/ State - POTW[2]
MD-Susquehanna	0.06	1.34	0.11	0.07	0.00	0.05	1.63	1.61	0.05
NY-Susquehanna	7.96	21.58	1.13	10.18	0.00	4.54	45.40	20.31	0.00
PA-Susquehanna	32.07	82.91	3.82	57.68	4.14	16.22	196.83	98.56	0.00
Susquehanna	40.08	105.83	5.07	67.93	4.14	20.81	243.86	120.48	0.05
DC-Potomac	0.00	8.35	0.03	25.71	0.00	0.00	34.09	0.00	0.00
MD-Potomac	1.94	44.23	1.02	18.27	1.76	0.64	67.86	15.58	9.59
PA-Potomac	3.89	4.49	0.24	2.28	0.00	1.12	12.02	11.08	0.00
VA-Potomac	13.61	66.52	1.27	21.39	1.24	-0.09	103.94	25.89	1.57
WV-Potomac	9.80	7.50	0.38	2.42	0.61	1.65	22.36	14.21	0.00
Potomac	29.24	131.09	2.94	70.07	3.62	3.31	240.27	66.76	11.16
MD-W. Shore MD	0.20	41.93	1.06	28.01	0.05	0.19	71.43	4.11	16.47
PA-W. Shore MD	0.03	0.02	0.00	0.00	0.00	0.00	0.06	0.10	0.00
W. Shore MD	0.23	41.95	1.06	28.01	0.05	0.19	71.49	4.22	16.47
DE-E. Shore MD	2.09	2.39	0.18	0.79	0.00	0.07	5.52	7.31	0.00
MD-E. Shore MD	0.15	12.14	0.61	6.62	0.00	0.99	20.51	24.58	3.76
PA-E. Shore MD	0.19	0.27	0.04	0.00	0.00	0.02	0.52	0.66	0.00
VA-E. Shore MD	0.06	0.05	0.00	0.00	0.00	0.00	0.11	0.23	0.00
E. Shore MD	2.49	14.85	0.83	7.41	0.00	1.08	26.66	32.78	3.76
MD-Patuxent	-0.07	19.91	0.44	1.54	0.87	0.13	22.81	1.45	0.84
Patuxent	-0.07	19.91	0.44	1.54	0.87	0.13	22.81	1.45	0.84

Exhibit 35: Annual Costs by State Basin for Tier 3 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Forest	Subtotal	Federal/ State - Agriculture[1]	Federal/ State - POTW[2]
VA-Rappahannock	5.27	10.79	0.44	4.92	0.00	0.72	22.15	12.51	0.41
Rappahannock	5.27	10.79	0.44	4.92	0.00	0.72	22.15	12.51	0.41
VA-York	3.19	11.48	0.58	4.30	0.14	1.67	21.36	9.26	0.35
York	3.19	11.48	0.58	4.30	0.14	1.67	21.36	9.26	0.35
VA-James	15.86	80.69	1.6	62.82	6.30	2.84	170.10	28.85	4.76
WV-James	0.07	0.01	0.00	0.00	0.00	0.01	0.09	0.10	0.00
James	15.93	80.71	1.6	62.82	6.30	2.85	170.20	28.94	4.76
VA-E. Shore VA	0.54	0.96	0.06	0.68	0.25	0.00	2.49	2.97	0.06
E. Shore VA	0.54	0.96	0.06	0.68	0.25	0.00	2.49	2.97	0.06
Total	**96.91**	**417.57**	**13.03**	**247.67**	**15.35**	**30.75**	**821.28**	**279.37**	**37.86**

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

1. Includes several programs for installation and other cost-sharing.
2. POTW capital costs are shared at 50% for MD facilities, at 10% for VA facilities, and at zero for other states and the District of Columbia.

In Tier 2, the Susquehanna Basin's share of total annual costs increases to 34%, and the Potomac Basin's share declines slightly to 26%. The James Basin accounts for 18% of total annual costs, and for 29% of total POTW costs. Costs for the Maryland West Shore decline from 12% to 6% of total annual costs, demonstrating the effect of Maryland's relatively high Tier 1 expenditures, particularly on POTW controls. The Susquehanna Basin has 43% of total agricultural sector costs; the Potomac Basin's share is much smaller–26% of total sector costs. The Susquehanna and Potomac Basins each have 25% of the total POTW costs.

The distribution of costs for Tier 3 is similar to Tier 2. The Susquehanna Basin retains the highest share—32%—with costs dominated by agricultural costs. The Potomac Basin has the second highest share of total annual costs (28%), and the James Basin the third highest share (18%). The Potomac Basin has 31% of urban sector costs throughout the Chesapeake Bay watershed, and the James Basin has 19%. These two watersheds also have high POTW costs—the Potomac Basin has 28% of total POTW costs and the James has 24%.

Exhibits 36 through **38** provide a summary of capital costs by state basin and basin as well as sector detail, similar to Exhibits 33 through 35. There are no capital costs for the forestry BMP and, therefore, this sector is not shown. The distribution of capital costs is similar to the distribution of annual costs, with some exceptions. In Tier 1, the Potomac contributes 34% of total capital costs while the Susquehanna and Maryland West Shore Basins each contribute 18%. The James contributes 11% and the Maryland East Shore contributes 10%; all other basins have less than 5% of the capital costs. POTW capital costs dominate Tier 1 costs in the Potomac and the Maryland East and West Shore Basins, while agricultural capital costs contribute most to Tier 1 costs in the Susquehanna Basin.

In Tier 2, the Susquehanna Basin's share of total capital costs rises to 28%, while the Potomac's share drops to 27%. The James Basin contributes 22% of total capital costs, and the other basins all have less than 10% each. The Susquehanna has the highest share of agricultural costs (40%), the Potomac has the highest share of urban costs (32%), and the James contributes most to POTW capital costs (30%).

In Tier 3, the Potomac Basin once again has the highest share of total capital costs at 30%. The Susquehanna contributes 28%, the James Basin contributes 19%, the Maryland West Shore has 11%, and the remaining basins contribute less than 5% each. The Potomac has the greatest share of urban costs (31%) and POTW costs (29%), reflecting the relatively high implementation of urban storm water retrofits in the Potomac watershed. The Susquehanna contributes the highest share of agricultural capital costs (40%), which reflects the large agricultural sector in the Susquehanna watershed.

3.2 Detailed Cost Estimates

Exhibit 39 shows the BMP costs for each state for Tiers 1–3, calculated by multiplying the acres shown in Exhibit 4 and the unit costs shown in Exhibit 16 (note that the acres shown in Exhibit 4 are rounded). Negative total costs indicate a reduction in BMP acres compared to the Progress 2000 Scenario because of a change from agriculture to another land use. Negative farmer costs indicate a cost savings (i.e., that estimated state and federal contributions exceed the cost of the BMP). Capital cost-sharing does not exceed 100% of capital costs, since none of the identified cost-share programs permit this, but the sum of upfront capital cost-share, incentive payments, *and* annual maintenance payments exceeds the annual cost of the BMP when farmer costs are negative.

Exhibit 36: Capital Costs by State Basin for Tier 1 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Total
MD-Susquehanna	1.23	6.52	0.00	0.00	0.00	7.75
NY-Susquehanna	7.47	13.00	0.00	0.00	0.00	20.48
PA-Susquehanna	99.55	71.35	0.00	65.68	0.00	236.58
Susquehanna	108.26	90.87	0.00	65.68	0.00	264.80
DC-Potomac	0.00	2.58	0.00	130.00	0.00	132.58
MD-Potomac	31.76	71.01	0.00	63.64	0.00	166.40
PA-Potomac	10.62	4.26	0.00	6.40	0.00	21.28
VA-Potomac	41.93	70.89	0.00	17.96	0.00	130.79
WV-Potomac	27.76	6.84	0.00	0.00	0.00	34.60
Potomac	112.07	155.59	0.00	218.00	0.00	485.65
MD-W. Shore MD	3.28	48.86	0.00	208.00	0.00	260.14
PA-W. Shore MD	0.09	0.01	0.00	0.00	0.00	0.10
W. Shore MD	3.37	48.87	0.00	208.00	0.00	260.24
DE-E. Shore MD	14.42	3.58	0.00	3.19	0.00	21.18
MD-E. Shore MD	13.39	19.11	0.00	84.35	0.00	116.85
PA-E. Shore MD	0.42	0.12	0.00	0.00	0.00	0.54
VA-E. Shore MD	0.39	0.02	0.00	0.00	0.00	0.41
E. Shore MD	28.61	22.83	0.00	87.54	0.00	138.97
MD-Patuxent	-0.03	40.83	0.00	0.00	0.00	40.79
Patuxent	-0.03	40.83	0.00	0.00	0.00	40.79
VA-Rappahannock	14.95	14.08	0.00	12.58	0.00	41.62
Rappahannock	14.95	14.08	0.00	12.58	0.00	41.62
VA-York	12.85	14.65	0.00	23.16	0.00	50.66
York	12.85	14.65	0.00	23.16	0.00	50.66
VA-James	28.66	86.38	0.00	40.25	0.00	155.28
WV-James	0.17	0.00	0.00	0.00	0.00	0.17
James	28.82	86.38	0.00	40.25	0.00	155.45
VA-E. Shore VA	3.33	0.41	0.00	0.00	0.00	3.74
E. Shore VA	3.33	0.41	0.00	0.00	0.00	3.74
Total	**312.23**	**474.50**	**0.00**	**655.20**	**0.00**	**1,441.93**

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

Exhibit 37: Capital Costs by State Basin for Tier 2 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Total
MD-Susquehanna	2.08	8.01	0.00	0.00	0.00	10.10
NY-Susquehanna	61.95	48.37	0.00	65.16	0.00	175.48
PA-Susquehanna	279.08	203.10	0.00	334.65	18.12	834.96
Susquehanna	343.11	259.49	0.00	399.81	18.12	1,020.53
DC-Potomac	0.00	16.14	0.00	154.26	0.00	170.40
MD-Potomac	46.56	136.87	0.00	89.14	5.00	277.56
PA-Potomac	32.36	11.41	0.00	17.37	0.00	61.13
VA-Potomac	102.41	175.10	0.00	71.04	9.29	357.85
WV-Potomac	70.17	19.11	0.00	21.30	5.29	115.86
Potomac	251.50	358.63	0.00	353.10	19.58	982.81
MD-W. Shore MD	6.54	113.57	0.00	218.00	0.00	338.12
PA-W. Shore MD	0.23	0.05	0.00	0.00	0.00	0.28
W. Shore MD	6.77	113.62	0.00	218.00	0.00	338.39
DE-E. Shore MD	22.29	7.40	0.00	5.82	0.00	35.51
MD-E. Shore MD	32.42	37.65	0.00	85.86	0.00	155.93
PA-E. Shore MD	1.82	0.56	0.00	0.00	0.00	2.38
VA-E. Shore MD	0.67	0.10	0.00	0.00	0.00	0.77
E. Shore MD	57.19	45.72	0.00	91.67	0.00	194.58
MD-Patuxent	1.31	69.64	0.00	0.00	7.35	78.30
Patuxent	1.31	69.64	0.00	0.00	7.35	78.30
VA-Rappahannock	42.14	30.72	0.00	30.59	0.00	103.45
Rappahannock	42.14	30.72	0.00	30.59	0.00	103.45
VA-York	29.52	32.56	0.00	35.88	0.00	97.96
York	29.52	32.56	0.00	35.88	0.00	97.96
VA-James	111.50	215.21	0.00	479.32	5.75	811.78
WV-James	0.47	0.02	0.00	0.00	0.00	0.50
James	111.98	215.23	0.00	479.32	5.75	812.28
VA-E. Shore VA	6.85	2.02	0.00	6.75	0.01	15.63
E. Shore VA	6.85	2.02	0.00	6.75	0.01	15.63
Total	**850.38**	**1,127.63**	**0.00**	**1,615.12**	**50.81**	**3,643.93**

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

Exhibit 38: Capital Costs by State Basin for Tier 3 (millions of 2001 $)

Statebasin	Agriculture	Urban & Mixed Open	Onsite Systems	POTW	Industrial	Total
MD-Susquehanna	3.24	10.28	0.59	1.50	0.00	15.61
NY-Susquehanna	127.49	165.82	5.94	105.76	0.00	405.01
PA-Susquehanna	469.27	647.43	20.07	646.11	35.08	1,817.96
Susquehanna	600.00	823.53	26.60	753.37	35.08	2,238.58
DC-Potomac	0.00	64.40	0.17	303.51	0.00	368.08
MD-Potomac	60.35	341.70	5.37	304.15	10.00	721.58
PA-Potomac	54.92	35.05	1.27	24.61	0.00	115.85
VA-Potomac	182.08	512.67	6.65	219.91	10.76	932.06
WV-Potomac	134.28	57.69	1.98	31.50	5.74	231.19
Potomac	431.64	1,011.51	15.45	883.68	26.49	2,368.77
MD-W. Shore MD	10.16	324.25	5.55	528.46	0.40	868.81
PA-W. Shore MD	0.37	0.17	0.01	0.00	0.00	0.55
W. Shore MD	10.52	324.42	5.56	528.46	0.40	869.36
DE-E. Shore MD	31.60	18.26	0.95	9.00	0.00	59.81
MD-E. Shore MD	51.89	93.70	3.22	120.68	0.00	269.49
PA-E. Shore MD	3.08	2.09	0.19	0.00	0.00	5.37
VA-E. Shore MD	0.87	0.39	0.02	0.00	0.00	1.28
E. Shore MD	87.45	114.44	4.37	129.68	0.00	335.95
MD-Patuxent	2.68	154.19	2.33	26.82	7.84	193.86
Patuxent	2.68	154.19	2.33	26.82	7.84	193.86
VA-Rappahannock	76.35	83.06	2.30	56.39	0.00	218.11
Rappahannock	76.35	83.06	2.30	56.39	0.00	218.11
VA-York	48.86	88.78	3.02	48.67	0.00	189.34
York	48.86	88.78	3.02	48.67	0.00	189.34
VA-James	221.89	625.25	8.39	652.03	27.19	1,534.74
WV-James	0.97	0.08	0.01	0.00	0.00	1.05
James	222.85	625.33	8.39	652.03	27.19	1,535.79
VA-E. Shore VA	9.55	7.46	0.32	7.76	0.63	25.72
E. Shore VA	9.55	7.46	0.32	7.76	0.63	25.72
Total	**1,489.91**	**3,232.72**	**68.35**	**3,086.87**	**97.63**	**7,975.47**

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 1: Delaware (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	234	2,797	234
Grass Buffers	9,605	74,167	9,605
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	79,964	617,844	79,964
Storm Water Management on New Dev.	361,963	2,796,733	361,963
Nutrient Management	31,612	86,086	31,612
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	483,377	3,577,627	483,377

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	650,607	3,304,451	41,375	374,773	57,912	592,695
Grass Buffers	127,076	141,013	0	108,814	-3,088	130,164
Wetland Restoration	39,577	234,091	7,166	17,183	8,104	31,472
Retirement of Highly Erodible Land	0	0	0	0	0	0
Tree Planting	0	0	0	0	0	0
Farm Plans	0	0	0	0	0	0
Cover Crops	0	0	0	0	0	0
Stream Protection w/ Fencing	0	0	0	0	0	0
Stream Protection w/o Fencing	0	0	0	0	0	0
Nutrient Management Plan Implementation[4]	1,167,989	10,602,410	0	0	622,371	545,618
Grazing Land Protection	0	0	0	0	0	0
Animal Waste Management Systems	31,905	137,963	14,038	0	18,505	13,400
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	221,702	0	221,702	0	0	221,702
Conservation Tillage	1,962	0	1,962	0	1,962	0
Total	2,240,817	14,419,927	286,243	500,770	705,766	1,535,051

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	14,685

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	239,875	3,187,400	63,244
Industrial	0	0	0
Total	239,875	3,187,400	63,244

All Sources	Total Annual	Capital	Annual O&M
Total	2,978,754	21,184,954	832,863

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 1: District of Columbia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	60	714	60
Grass Buffers	2,451	18,924	2,451
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	331,687	2,562,806	331,687
Storm Water Management on New Dev.	0	0	0
Nutrient Management	0	0	0
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	334,198	2,582,444	334,198

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	0	0	0	0	0	0
Grass Buffers	0	0	0	0	0	0
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	0	0	0	0	0	0
Tree Planting	0	0	0	0	0	0
Farm Plans	0	0	0	0	0	0
Cover Crops	0	0	0	0	0	0
Stream Protection w/ Fencing	0	0	0	0	0	0
Stream Protection w/o Fencing	0	0	0	0	0	0
Nutrient Management Plan Implementation[4]	0	0	0	0	0	0
Grazing Land Protection	0	0	0	0	0	0
Animal Waste Management Systems	0	0	0	0	0	0
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	0	0	0	0	0	0
Total	0	0	0	0	0	0

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	0

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	8,260,558	130,000,000	0
Industrial	0	0	0
Total	8,260,558	130,000,000	0

All Sources	Total Annual	Capital	Annual O&M
Total	8,594,755	132,582,444	334,198

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002). Costs for the District of Columbia include CSO controls.

Exhibit 39: Estimated Costs of Tier 1: Maryland (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	572,384	6,857,076	572,384
Grass Buffers	340,710	2,630,870	340,710
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	4,195,385	32,415,941	4,195,385
Storm Water Management on New Dev.	18,691,867	144,424,027	18,691,867
Nutrient Management	0	0	0
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	23,800,346	186,327,914	23,800,346

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	3,891,132	23,075,131	288,924	1,964,971	-140,342	4,031,475
Grass Buffers	1,024,591	1,011,164	0	893,640	-99,176	1,123,766
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	157,261	180,675	0	133,863	-17,721	174,982
Tree Planting	0	0	0	0	0	0
Farm Plans	830,139	4,481,575	249,755	0	322,303	507,836
Cover Crops	-862,958	0	-862,958	0	-223,730	-639,228
Stream Protection w/ Fencing	1,504,720	8,365,718	421,322	0	556,747	947,974
Stream Protection w/o Fencing	222,346	1,236,169	62,257	0	82,268	140,078
Nutrient Management Plan Implementation[4]	872,566	7,920,713	0	0	623,261	249,305
Grazing Land Protection	0	0	0	0	0	0
Animal Waste Management Systems	772,924	3,342,256	340,087	0	394,191	378,733
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	-13,153	0	-13,153	0	0	-13,153
Conservation Tillage	-145,758	0	-145,758	0	-145,758	0
Total	8,253,812	49,613,399	340,476	2,992,474	1,352,044	6,901,768

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	1,592,527

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	29,478,054	355,985,619	7,284,694
Industrial	0	0	0
Total	29,478,054	355,985,619	7,284,694

All Sources	Total Annual	Capital	Annual O&M
Total	63,124,740	591,926,932	31,425,516

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 1: New York (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	1,965	23,545	1,965
Grass Buffers	80,840	624,228	80,840
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	806,622	6,232,423	806,622
Storm Water Management on New Dev.	792,426	6,122,733	792,426
Nutrient Management	0	0	0
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	1,681,854	13,002,928	1,681,854

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	0	0	0	0	0	0
Grass Buffers	0	0	0	0	0	0
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	433,622	789,762	0	331,345	-17,297	450,919
Tree Planting	0	0	0	0	0	0
Farm Plans	0	0	0	0	0	0
Cover Crops	0	0	0	0	0	0
Stream Protection w/ Fencing	0	0	0	0	0	0
Stream Protection w/o Fencing	0	0	0	0	0	0
Nutrient Management Plan Implementation[4]	126,281	1,146,315	0	0	15,785	110,496
Grazing Land Protection	209,254	1,163,380	58,591	0	77,424	131,830
Animal Waste Management Systems	1,011,757	4,375,012	445,173	0	515,996	495,761
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	29,853	0	29,853	0	29,853	0
Total	1,810,767	7,474,468	533,617	331,345	621,761	1,189,006

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	3,635,376

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	0	0	0
Industrial	0	0	0
Total	0	0	0

All Sources	Total Annual	Capital	Annual O&M
Total	7,127,997	20,477,397	2,215,471

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 1: Pennsylvania (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	1,787,376	21,412,504	1,787,376
Grass Buffers	393,284	3,036,834	393,284
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	3,227,571	24,938,052	3,227,571
Storm Water Management on New Dev.	3,409,722	26,345,454	3,409,722
Nutrient Management	0	0	0
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	8,817,952	75,732,844	8,817,952

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	223,036	1,312,681	16,436	113,462	11,363	211,673
Grass Buffers	37,194	34,236	0	32,760	-1,304	38,498
Wetland Restoration	81,106	489,136	14,974	34,313	12,957	68,149
Retirement of Highly Erodible Land	537,128	687,003	0	448,158	-26,168	563,295
Tree Planting	0	0	0	0	0	0
Farm Plans	7,988,447	43,146,864	2,400,731	0	2,400,731	5,587,716
Cover Crops	0	0	0	0	0	0
Stream Protection w/ Fencing	713,633	3,967,546	199,817	0	199,817	513,815
Stream Protection w/o Fencing	55,927	310,933	15,659	0	23,713	32,214
Nutrient Management Plan Implementation[4]	1,434,155	13,018,531	0	0	286,831	1,147,324
Grazing Land Protection	86,218	479,342	24,141	0	36,556	49,662
Animal Waste Management Systems	10,923,744	47,236,144	4,806,447	0	6,029,907	4,893,837
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	9,617	0	9,617	0	9,617	0
Conservation Tillage	158,920	0	158,920	0	158,920	0
Total	22,249,124	110,682,417	7,646,743	628,693	9,142,941	13,106,184

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	13,880,287

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	6,490,146	72,079,813	1,866,433
Industrial	0	0	0
Total	6,490,146	72,079,813	1,866,433

All Sources	Total Annual	Capital	Annual O&M
Total	51,437,510	258,495,073	18,331,128

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.
1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 1: Virginia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	18,367	220,036	18,367
Grass Buffers	755,486	5,833,663	755,486
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	6,158,798	47,586,385	6,158,798
Storm Water Management on New Dev.	17,170,631	132,670,093	17,170,631
Nutrient Management	45,366	123,542	45,366
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	24,148,648	186,433,719	24,148,648

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	847,877	5,349,858	66,986	401,306	115,364	732,513
Grass Buffers	162,030	181,989	0	138,462	-9,705	171,735
Wetland Restoration	201,687	1,214,791	37,188	85,476	45,673	156,014
Retirement of Highly Erodible Land	3,383,002	4,119,205	0	2,849,546	-219,658	3,602,660
Tree Planting	0	0	0	0	0	0
Farm Plans	9,073,602	48,538,411	2,787,656	0	4,359,143	4,714,460
Cover Crops	-946,558	0	-946,558	0	-236,639	-709,918
Stream Protection w/ Fencing	1,057,642	5,880,117	296,140	0	486,515	571,127
Stream Protection w/o Fencing	0	0	0	0	0	0
Nutrient Management Plan Implementation[4]	1,467,264	13,319,083	0	0	838,437	628,828
Grazing Land Protection	2,881,677	16,021,111	806,869	0	1,325,571	1,556,105
Animal Waste Management Systems	1,730,494	7,482,955	761,418	0	1,003,687	726,808
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	1,827,469	0	1,827,469	0	1,827,469	0
Conservation Tillage	-105,986	0	-105,986	0	-105,986	0
Total	21,580,201	102,107,520	5,531,181	3,474,789	9,429,871	12,150,330

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	3,019,242

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	8,650,293	93,947,837	1,798,521
Industrial	0	0	0
Total	8,650,293	93,947,837	1,798,521

All Sources	Total Annual	Capital	Annual O&M
Total	57,398,385	382,489,077	31,478,351

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 1: West Virginia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	802	9,612	802
Grass Buffers	33,004	254,845	33,004
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	270,464	2,089,761	270,464
Storm Water Management on New Dev.	581,455	4,492,653	581,455
Nutrient Management	0	0	0
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	885,725	6,846,872	885,725

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	39,340	321,293	4,023	12,520	8,480	30,859
Grass Buffers	25,004	48,685	0	18,699	-278	25,282
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	21,921	48,760	0	15,606	-279	22,200
Tree Planting	0	0	0	0	0	0
Farm Plans	3,041,942	16,227,374	940,423	0	1,465,803	1,576,139
Cover Crops	-9,421	0	-9,421	0	-2,355	-7,065
Stream Protection w/ Fencing	62,432	347,103	17,481	0	28,719	33,714
Stream Protection w/o Fencing	275	1,531	77	0	127	149
Nutrient Management Plan Implementation[4]	113,956	1,034,433	0	0	28,489	85,467
Grazing Land Protection	1,544,232	8,585,385	432,385	0	710,346	833,885
Animal Waste Management Systems	303,591	1,312,778	133,580	0	176,083	127,508
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	-25,815	0	-25,815	0	-25,815	0
Total	5,117,457	27,927,343	1,492,733	46,825	2,389,320	2,728,137

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	1,328,544

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	0	0	0
Industrial	0	0	0
Total	0	0	0

All Sources	Total Annual	Capital	Annual O&M
Total	7,331,726	34,774,215	2,378,458

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 2: Delaware (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	12,439	149,013	12,439
Grass Buffers	8,644	66,749	8,644
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	499,772	3,861,523	499,772
Storm Water Management on New Dev.	411,322	3,178,105	411,322
Nutrient Management	54,452	148,286	54,452
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	986,628	7,403,677	986,628

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	1,083,343	5,522,386	69,146	622,370	96,783	986,560
Grass Buffers	254,741	275,772	0	219,028	-6,040	260,781
Wetland Restoration	39,577	234,091	7,166	17,183	8,104	31,472
Retirement of Highly Erodible Land	1,059,660	1,676,070	0	842,601	-36,708	1,096,368
Tree Planting	0	0	0	0	0	0
Farm Plans	829,226	4,479,396	249,124	0	321,637	507,590
Cover Crops	1,679,761	0	1,679,761	0	419,940	1,259,821
Stream Protection w/ Fencing	17,447	97,000	4,885	0	8,026	9,421
Stream Protection w/o Fencing	7,130	39,639	1,996	0	3,280	3,850
Nutrient Management Plan Implementation[4]	1,061,261	9,633,587	0	0	565,500	495,760
Grazing Land Protection	30,401	169,019	8,512	0	13,984	16,417
Animal Waste Management Systems	37,044	160,183	16,299	0	21,485	15,558
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	221,972	0	221,972	0	0	221,972
Conservation Tillage	13,249	0	13,249	0	13,249	0
Total	6,334,812	22,287,143	2,272,111	1,701,181	1,429,241	4,905,571

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	44,020

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	552,811	5,815,797	230,527
Industrial	0	0	0
Total	552,811	5,815,797	230,527

All Sources	Total Annual	Capital	Annual O&M
Total	7,918,271	35,506,616	3,489,266

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 2: District of Columbia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	3,174	38,021	3,174
Grass Buffers	2,206	17,031	2,206
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	2,076,376	16,043,269	2,076,376
Storm Water Management on New Dev.	0	0	0
Nutrient Management	14,385	39,173	14,385
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	2,096,140	16,137,494	2,096,140

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	0	0	0	0	0	0
Grass Buffers	0	0	0	0	0	0
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	0	0	0	0	0	0
Tree Planting	0	0	0	0	0	0
Farm Plans	0	0	0	0	0	0
Cover Crops	0	0	0	0	0	0
Stream Protection w/ Fencing	0	0	0	0	0	0
Stream Protection w/o Fencing	0	0	0	0	0	0
Nutrient Management Plan Implementation[4]	0	0	0	0	0	0
Grazing Land Protection	0	0	0	0	0	0
Animal Waste Management Systems	0	0	0	0	0	0
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	0	0	0	0	0	0
Total	0	0	0	0	0	0

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	0

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	14,069,871	154,263,400	4,267,550
Industrial	0	0	0
Total	14,069,871	154,263,400	4,267,550

All Sources	Total Annual	Capital	Annual O&M
Total	16,166,011	170,400,894	6,363,690

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002). Costs for the District of Columbia include CSO controls.

Exhibit 39: Estimated Costs of Tier 2: Maryland (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	1,039,840	12,457,130	1,039,840
Grass Buffers	303,006	2,339,734	303,006
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	26,216,002	202,559,788	26,216,002
Storm Water Management on New Dev.	18,922,461	146,205,730	18,922,461
Nutrient Management	800,481	2,179,909	800,481
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	47,281,791	365,742,292	47,281,791

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	8,805,605	52,510,649	657,487	4,422,358	-319,368	9,124,973
Grass Buffers	2,412,068	2,589,720	0	2,076,687	-254,001	2,666,069
Wetland Restoration	961,043	6,002,266	183,744	386,843	158,301	802,742
Retirement of Highly Erodible Land	9,858,895	11,539,825	0	8,364,435	-1,131,834	10,990,729
Tree Planting	0	0	0	0	0	0
Farm Plans	-984,682	-5,313,725	-296,530	0	-382,549	-602,133
Cover Crops	8,699,357	0	8,699,357	0	2,255,389	6,443,968
Stream Protection w/ Fencing	1,739,112	9,668,850	486,951	0	643,471	1,095,640
Stream Protection w/o Fencing	227,298	1,263,699	63,644	0	84,100	143,198
Nutrient Management Plan Implementation[4]	43,723	396,894	0	0	31,231	12,492
Grazing Land Protection	1,213,802	6,748,311	339,864	0	449,107	764,695
Animal Waste Management Systems	810,839	3,506,205	356,769	0	413,528	397,311
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	-14,655	0	-14,655	0	0	-14,655
Conservation Tillage	9,974	0	9,974	0	9,974	0
Total	33,782,377	88,912,693	10,486,604	15,250,323	1,957,348	31,825,029

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	1,791,593

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	36,180,908	392,994,846	11,651,128
Industrial	1,637,472	12,350,911	581,548
Total	37,818,381	405,345,756	12,232,676

All Sources	Total Annual	Capital	Annual O&M
Total	120,674,142	860,000,742	70,001,072

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 2: New York (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	104,690	1,254,168	104,690
Grass Buffers	72,755	561,792	72,755
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	5,041,389	38,952,644	5,041,389
Storm Water Management on New Dev.	900,484	6,957,651	900,484
Nutrient Management	235,687	641,833	235,687
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	6,355,003	48,368,088	6,355,003

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	1,584,359	12,404,134	155,312	548,943	217,389	1,366,969
Grass Buffers	237,642	408,479	0	184,742	-8,946	246,588
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	2,321,127	3,954,102	0	1,809,053	-86,601	2,407,728
Tree Planting	0	0	0	0	0	0
Farm Plans	2,621,314	14,048,270	801,998	0	1,029,413	1,591,901
Cover Crops	2,246,571	0	2,246,571	0	280,821	1,965,750
Stream Protection w/ Fencing	782,184	4,348,670	219,012	0	289,408	492,776
Stream Protection w/o Fencing	319,643	1,777,101	89,500	0	118,268	201,375
Nutrient Management Plan Implementation[4]	941,937	8,550,427	0	0	117,742	824,195
Grazing Land Protection	1,262,326	7,018,088	353,451	0	467,060	795,265
Animal Waste Management Systems	2,182,852	9,439,027	960,455	0	1,113,255	1,069,598
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	167,524	0	167,524	0	167,524	0
Total	14,667,478	61,948,298	4,993,823	2,542,738	3,705,333	10,962,145

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	4,089,798

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	6,235,642	65,159,566	2,055,843
Industrial	0	0	0
Total	6,235,642	65,159,566	2,055,843

All Sources	Total Annual	Capital	Annual O&M
Total	31,347,921	175,475,952	13,404,669

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 2: Pennsylvania (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	2,351,317	28,168,437	2,351,317
Grass Buffers	352,798	2,724,214	352,798
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	20,166,570	155,818,424	20,166,570
Storm Water Management on New Dev.	3,412,988	26,370,696	3,412,988
Nutrient Management	747,517	2,035,675	747,517
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	27,031,192	215,117,445	27,031,192

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	12,529,675	75,215,200	941,771	6,251,200	651,101	11,878,574
Grass Buffers	3,657,998	3,727,866	0	3,175,222	-141,993	3,799,991
Wetland Restoration	303,268	1,797,060	55,012	131,355	47,602	255,666
Retirement of Highly Erodible Land	19,254,172	23,661,964	0	16,189,839	-901,274	20,155,446
Tree Planting	0	0	0	0	0	0
Farm Plans	11,140,394	59,484,892	3,436,828	0	3,436,828	7,703,566
Cover Crops	16,610,845	0	16,610,845	0	7,382,598	9,228,247
Stream Protection w/ Fencing	3,097,505	17,221,042	867,301	0	867,301	2,230,204
Stream Protection w/o Fencing	1,022,835	5,686,604	286,394	0	433,682	589,153
Nutrient Management Plan Implementation[4]	5,639,185	51,189,665	0	0	1,127,837	4,511,348
Grazing Land Protection	3,238,242	18,003,488	906,708	0	1,373,014	1,865,227
Animal Waste Management Systems	13,298,399	57,504,561	5,851,296	0	7,340,717	5,957,683
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	406,072	0	406,072	0	406,072	0
Conservation Tillage	734,105	0	734,105	0	734,105	0
Total	90,932,696	313,492,341	30,096,333	25,747,616	22,757,591	68,175,104

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	15,615,323

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	31,784,614	352,016,372	9,203,774
Industrial	2,043,399	18,123,358	493,968
Total	33,828,013	370,139,730	9,697,742

All Sources	Total Annual	Capital	Annual O&M
Total	167,407,224	898,749,516	66,825,267

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 2: Virginia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	972,497	11,650,369	972,497
Grass Buffers	675,841	5,218,663	675,841
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	38,488,376	297,383,150	38,488,376
Storm Water Management on New Dev.	17,864,470	138,031,087	17,864,470
Nutrient Management	1,264,150	3,442,593	1,264,150
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	59,265,334	455,725,862	59,265,334

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	9,758,239	63,154,108	790,754	4,486,546	1,361,854	8,396,385
Grass Buffers	1,494,822	1,780,341	0	1,264,260	-94,937	1,589,760
Wetland Restoration	479,241	2,939,844	89,996	198,004	110,531	368,710
Retirement of Highly Erodible Land	10,418,034	12,811,532	0	8,758,882	-683,180	11,101,214
Tree Planting	0	0	0	0	0	0
Farm Plans	13,403,197	71,609,558	4,129,431	0	6,447,873	6,955,324
Cover Crops	6,197,876	0	6,197,876	0	1,549,469	4,648,407
Stream Protection w/ Fencing	6,274,538	34,884,232	1,756,871	0	2,886,288	3,388,251
Stream Protection w/o Fencing	2,140,090	11,898,149	599,225	0	984,441	1,155,649
Nutrient Management Plan Implementation[4]	2,900,010	26,324,820	0	0	1,657,148	1,242,861
Grazing Land Protection	10,477,739	58,252,555	2,933,767	0	4,819,760	5,657,979
Animal Waste Management Systems	2,183,733	9,442,837	960,843	0	1,266,565	917,168
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	2,108,290	0	2,108,290	0	2,108,290	0
Conservation Tillage	36,521	0	36,521	0	36,521	0
Total	67,872,330	293,097,977	19,603,573	14,707,692	22,450,623	45,421,708

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	4,077,351

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	57,856,930	623,564,696	12,421,018
Industrial	3,411,858	15,051,365	2,125,063
Total	61,268,788	638,616,061	14,546,080

All Sources	Total Annual	Capital	Annual O&M
Total	192,483,803	1,387,439,899	93,414,987

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 2: West Virginia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	42,740	512,023	42,740
Grass Buffers	29,703	229,355	29,703
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	1,690,402	13,061,008	1,690,402
Storm Water Management on New Dev.	660,744	5,105,287	660,744
Nutrient Management	81,873	222,961	81,873
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	2,505,462	19,130,634	2,505,462

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	1,553,131	13,167,381	164,869	454,004	347,548	1,205,583
Grass Buffers	55,979	108,997	0	41,863	-623	56,602
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	825,639	1,836,510	0	587,803	-10,493	836,132
Tree Planting	0	0	0	0	0	0
Farm Plans	2,779,769	14,825,029	859,860	0	1,339,837	1,439,932
Cover Crops	327,115	0	327,115	0	81,779	245,337
Stream Protection w/ Fencing	2,091,315	11,626,979	585,568	0	962,005	1,129,310
Stream Protection w/o Fencing	829,179	4,609,942	232,170	0	381,422	447,756
Nutrient Management Plan Implementation[4]	381,612	3,464,082	0	0	95,403	286,209
Grazing Land Protection	3,324,960	18,485,609	930,989	0	1,529,481	1,795,478
Animal Waste Management Systems	582,122	2,517,194	256,134	0	337,631	244,491
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	-19,807	0	-19,807	0	-19,807	0
Total	12,731,013	70,641,723	3,336,897	1,083,670	5,044,183	7,686,830

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	1,494,612

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	0	0	0

Point Sources	Total Annual	Capital	Annual O&M
Municipal	1,667,872	21,301,901	522,764
Industrial	559,099	5,286,279	107,156
Total	2,226,971	26,588,180	629,920

All Sources	Total Annual	Capital	Annual O&M
Total	18,958,057	116,360,538	6,472,279

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 3: Delaware (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	36,847	441,417	36,847
Grass Buffers	6,723	51,915	6,723
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	1,999,088	15,446,093	1,999,088
Storm Water Management on New Dev.	274,214	2,118,737	274,214
Nutrient Management	72,586	197,669	72,586
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	2,389,458	18,255,831	2,389,458

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	1,274,902	6,494,628	81,319	732,773	113,822	1,161,080
Grass Buffers	341,376	366,849	0	293,868	-8,035	349,411
Wetland Restoration	39,594	234,183	7,169	17,191	8,108	31,486
Retirement of Highly Erodible Land	1,747,278	2,764,430	0	1,389,271	-60,545	1,807,823
Tree Planting	0	0	0	0	0	0
Farm Plans	1,758,609	9,484,031	530,383	0	683,912	1,074,697
Cover Crops	2,514,479	0	2,514,479	0	628,620	1,885,859
Stream Protection w/ Fencing	87,236	485,000	24,426	0	40,128	47,107
Stream Protection w/o Fencing	5,243	29,147	1,468	0	2,412	2,831
Nutrient Management Plan Implementation[4]	677,137	6,146,711	0	0	360,818	316,320
Grazing Land Protection	60,802	338,038	17,025	0	27,969	32,833
Animal Waste Management Systems	44,238	191,292	19,465	0	25,658	18,580
Yield Reserve[4]	316,092	2,869,325	0	0	0	316,092
Carbon Sequestration	285,037	2,200,976	0	0	285,037	0
Excess Manure Removal	262,177	0	262,177	0	0	262,177
Conservation Tillage	-22,371	0	-22,371	0	-22,371	0
Total	9,391,828	31,604,611	3,435,539	2,433,103	2,085,531	7,306,297

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	73,355

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	181,326	951,419	181,326

Point Sources	Total Annual	Capital	Annual O&M
Municipal	785,664	8,998,705	286,998
Industrial	0	0	0
Total	785,664	8,998,705	286,998

All Sources	Total Annual	Capital	Annual O&M
Total	12,821,630	59,810,566	6,293,321

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 3: District of Columbia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	9,401	112,628	9,401
Grass Buffers	1,715	13,246	1,715
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	8,308,836	64,198,805	8,308,836
Storm Water Management on New Dev.	0	0	0
Nutrient Management	26,949	73,388	26,949
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	8,346,901	64,398,067	8,346,901

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	0	0	0	0	0	0
Grass Buffers	0	0	0	0	0	0
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	0	0	0	0	0	0
Tree Planting	0	0	0	0	0	0
Farm Plans	0	0	0	0	0	0
Cover Crops	0	0	0	0	0	0
Stream Protection w/ Fencing	0	0	0	0	0	0
Stream Protection w/o Fencing	0	0	0	0	0	0
Nutrient Management Plan Implementation[4]	0	0	0	0	0	0
Grazing Land Protection	0	0	0	0	0	0
Animal Waste Management Systems	0	0	0	0	0	0
Yield Reserve[4]	0	0	0	0	0	0
Carbon Sequestration	0	0	0	0	0	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	0	0	0	0	0	0
Total	0	0	0	0	0	0

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	0

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	33,087	173,609	33,087

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	25,710,919	303,506,200	6,425,300
Industrial	0	0	0
Total	25,710,919	303,506,200	6,425,300

All Sources	Total Annual	Capital	Annual O&M
Total	34,090,908	368,077,876	14,805,289

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002). Costs for the District of Columbia include CSO controls.

Exhibit 39: Estimated Costs of Tier 3: Maryland (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	1,886,731	22,602,757	1,886,731
Grass Buffers	232,846	1,797,978	232,846
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	104,843,384	810,079,790	104,843,384
Storm Water Management on New Dev.	11,069,443	85,528,832	11,069,443
Nutrient Management	1,507,955	4,106,536	1,507,955
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	119,540,360	924,115,893	119,540,360

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	10,880,555	64,813,373	811,530	5,470,358	-394,193	11,274,748
Grass Buffers	3,370,826	3,692,917	0	2,892,576	-362,204	3,733,029
Wetland Restoration	1,922,412	12,004,531	367,488	774,012	316,602	1,605,810
Retirement of Highly Erodible Land	15,681,537	18,382,523	0	13,300,917	-1,802,970	17,484,508
Tree Planting	0	0	0	0	0	0
Farm Plans	-2,704,391	-14,744,417	-794,922	0	-1,033,605	-1,670,786
Cover Crops	12,885,030	0	12,885,030	0	3,340,563	9,544,467
Stream Protection w/ Fencing	2,873,335	15,974,733	804,534	0	1,063,134	1,810,201
Stream Protection w/o Fencing	163,730	910,283	45,844	0	60,580	103,150
Nutrient Management Plan Implementation[4]	-2,764,411	-25,093,921	0	0	-1,974,579	-789,832
Grazing Land Protection	2,428,946	13,504,087	680,105	0	898,710	1,530,236
Animal Waste Management Systems	863,919	3,735,733	380,124	0	440,599	423,320
Yield Reserve[4]	2,296,770	20,848,914	0	0	0	2,296,770
Carbon Sequestration	1,850,941	14,292,475	0	0	1,850,941	0
Excess Manure Removal	-8,577	0	-8,577	0	0	-8,577
Conservation Tillage	-132,705	0	-132,705	0	-132,705	0
Total	49,607,917	128,321,230	15,038,451	22,437,863	2,270,873	47,337,045

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	1,990,659

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	3,250,804	17,057,048	3,250,804

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	85,214,328	981,622,772	23,808,244
Industrial	2,676,421	18,239,006	1,117,102
Total	87,890,748	999,861,778	24,925,346

All Sources	Total Annual	Capital	Annual O&M
Total	262,280,488	2,069,355,949	162,754,961

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 3: New York (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	310,119	3,715,185	310,119
Grass Buffers	56,586	436,939	56,586
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	20,165,554	155,810,576	20,165,554
Storm Water Management on New Dev.	600,322	4,638,434	600,322
Nutrient Management	449,237	1,223,383	449,237
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	21,581,819	165,824,517	21,581,819

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	2,715,428	21,232,593	265,854	943,070	372,113	2,343,315
Grass Buffers	415,873	714,838	0	323,298	-15,656	431,529
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	3,722,815	6,389,951	0	2,895,287	-139,950	3,862,765
Tree Planting	0	0	0	0	0	0
Farm Plans	5,747,569	30,775,278	1,762,030	0	2,260,222	3,487,347
Cover Crops	3,355,143	0	3,355,143	0	419,393	2,935,750
Stream Protection w/ Fencing	3,884,525	21,596,594	1,087,667	0	1,437,274	2,447,250
Stream Protection w/o Fencing	233,445	1,297,872	65,365	0	86,375	147,070
Nutrient Management Plan Implementation[4]	974,582	8,846,765	0	0	121,823	852,760
Grazing Land Protection	2,300,132	12,787,924	644,037	0	851,049	1,449,083
Animal Waste Management Systems	3,822,385	16,528,648	1,681,849	0	1,949,416	1,872,969
Yield Reserve[4]	483,087	4,385,221	0	0	0	483,087
Carbon Sequestration	380,103	2,935,057	0	0	380,103	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	237,254	0	237,254	0	237,254	0
Total	28,272,341	127,490,741	9,099,198	4,161,655	7,959,416	20,312,925

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	4,544,220

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	1,131,503	5,937,023	1,131,503

Point Sources	Total Annual	Capital	Annual O&M
Municipal	10,184,157	105,760,184	3,399,944
Industrial	0	0	0
Total	10,184,157	105,760,184	3,399,944

All Sources	Total Annual	Capital	Annual O&M
Total	65,714,039	405,012,465	35,212,464

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 3: Pennsylvania (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	3,372,590	40,403,133	3,372,590
Grass Buffers	273,498	2,111,882	273,498
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	80,640,209	623,072,254	80,640,209
Storm Water Management on New Dev.	1,971,034	15,229,335	1,971,034
Nutrient Management	1,442,580	3,928,502	1,442,580
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	87,699,911	684,745,106	87,699,911

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	21,111,400	126,820,710	1,587,925	10,525,234	1,097,825	20,013,575
Grass Buffers	6,371,405	6,496,114	0	5,530,128	-247,434	6,618,839
Wetland Restoration	528,432	3,122,939	95,601	229,680	82,724	445,709
Retirement of Highly Erodible Land	30,058,820	36,977,925	0	25,270,009	-1,408,474	31,467,293
Tree Planting	0	0	0	0	0	0
Farm Plans	15,876,265	84,680,815	4,909,712	0	4,909,712	10,966,553
Cover Crops	24,719,849	0	24,719,849	0	10,986,599	13,733,249
Stream Protection w/ Fencing	12,508,191	69,541,155	3,502,294	0	3,502,294	9,005,898
Stream Protection w/o Fencing	746,558	4,150,602	209,036	0	316,541	430,018
Nutrient Management Plan Implementation[4]	3,849,996	34,948,310	0	0	769,999	3,079,996
Grazing Land Protection	6,335,106	35,220,968	1,773,830	0	2,686,085	3,649,021
Animal Waste Management Systems	16,622,917	71,880,344	7,314,083	0	9,175,850	7,447,067
Yield Reserve[4]	3,544,743	32,177,379	0	0	0	3,544,743
Carbon Sequestration	2,800,506	21,624,763	0	0	2,800,506	0
Excess Manure Removal	685,345	0	685,345	0	685,345	0
Conservation Tillage	821,257	0	821,257	0	821,257	0
Total	146,580,789	527,642,024	45,618,932	41,555,051	36,178,828	110,401,961

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	17,350,359

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	4,106,021	21,544,394	4,106,021

Point Sources	Total Annual	Capital	Annual O&M
Municipal	59,952,609	670,716,278	16,928,086
Industrial	4,136,284	35,078,315	1,137,311
Total	64,088,893	705,794,593	18,065,397

All Sources	Total Annual	Capital	Annual O&M
Total	319,825,974	1,939,726,117	155,490,261

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.
1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

Exhibit 39: Estimated Costs of Tier 3: Virginia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	2,863,404	34,303,155	2,863,404
Grass Buffers	522,468	4,034,356	522,468
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	153,911,083	1,189,204,823	153,911,083
Storm Water Management on New Dev.	10,814,275	83,557,256	10,814,275
Nutrient Management	2,391,345	6,512,225	2,391,345
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	170,502,574	1,317,611,815	170,502,574

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	15,165,870	97,987,186	1,226,900	6,986,538	2,112,994	13,052,876
Grass Buffers	2,483,348	2,966,709	0	2,099,145	-158,201	2,641,549
Wetland Restoration	764,019	4,708,912	144,151	313,546	177,044	586,975
Retirement of Highly Erodible Land	16,416,047	20,185,401	0	13,801,946	-1,076,395	17,492,442
Tree Planting	0	0	0	0	0	0
Farm Plans	18,557,806	98,973,867	5,740,238	0	8,944,630	9,613,176
Cover Crops	9,605,252	0	9,605,252	0	2,401,313	7,203,939
Stream Protection w/ Fencing	27,030,520	150,280,207	7,568,546	0	12,434,039	14,596,481
Stream Protection w/o Fencing	1,562,660	8,687,842	437,545	0	718,824	843,836
Nutrient Management Plan Implementation[4]	1,710,724	15,529,089	0	0	977,557	733,168
Grazing Land Protection	17,968,738	99,899,881	5,031,247	0	8,265,620	9,703,119
Animal Waste Management Systems	2,818,268	12,186,672	1,240,038	0	1,634,595	1,183,672
Yield Reserve[4]	2,056,859	18,671,127	0	0	0	2,056,859
Carbon Sequestration	1,233,866	9,527,582	0	0	1,233,866	0
Excess Manure Removal	926,890	0	926,890	0	926,890	0
Conservation Tillage	-48,363	0	-48,363	0	-48,363	0
Total	118,252,504	539,604,475	31,872,443	23,201,175	38,544,411	79,708,093

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	5,135,459

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	3,944,432	20,696,534	3,944,432

Point Sources	Total Annual	Capital	Annual O&M
Municipal[5]	101,254,416	984,760,302	29,732,400
Industrial	7,923,629	38,575,094	4,625,704
Total	109,178,044	1,023,335,396	34,358,104

All Sources	Total Annual	Capital	Annual O&M
Total	407,013,014	2,901,248,220	240,677,554

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

Exhibit 39: Estimated Costs of Tier 3: West Virginia (2001 $)

Urban	Total Annual	Capital	Annual O&M
Forest Buffers	126,608	1,516,750	126,608
Grass Buffers	23,101	178,383	23,101
Environmental Site Design / Low-Impact Dev.	0	0	0
Storm Water Retrofits	6,761,607	52,244,033	6,761,607
Storm Water Management on New Dev.	440,496	3,403,525	440,496
Nutrient Management	155,724	424,074	155,724
Urban Land Conversion	0	0	0
Forest Conservation	0	0	0
Total	7,507,537	57,766,765	7,507,537

Agriculture	Total Annual[1]	Capital	Annual O&M	Annual Land Rental[2]	Farmer Share of Annual Cost[3]	Federal/State Share of Annual Cost
Forest Buffers	2,497,590	21,113,284	264,360	735,191	557,277	1,940,313
Grass Buffers	77,029	149,985	0	57,606	-857	77,886
Wetland Restoration	0	0	0	0	0	0
Retirement of Highly Erodible Land	1,187,708	2,641,877	0	845,573	-15,094	1,202,802
Tree Planting	0	0	0	0	0	0
Farm Plans	2,600,177	13,857,990	805,504	0	1,254,172	1,346,005
Cover Crops	462,929	0	462,929	0	115,732	347,196
Stream Protection w/ Fencing	10,114,560	56,233,407	2,832,077	0	4,652,698	5,461,863
Stream Protection w/o Fencing	603,851	3,357,199	169,078	0	277,771	326,079
Nutrient Management Plan Implementation[4]	343,079	3,114,295	0	0	85,770	257,309
Grazing Land Protection	5,063,244	28,149,858	1,417,708	0	2,329,092	2,734,152
Animal Waste Management Systems	972,065	4,203,377	427,709	0	563,798	408,267
Yield Reserve[4]	206,059	1,870,497	0	0	0	206,059
Carbon Sequestration	72,145	557,087	0	0	72,145	0
Excess Manure Removal	0	0	0	0	0	0
Conservation Tillage	-24,525	0	-24,525	0	-24,525	0
Total	24,175,910	135,248,854	6,354,839	1,638,369	9,867,979	14,307,931

Forest	Total Annual
Forest Harvesting Practices (Erosion Control)	1,660,679

Onsite Wastewater Management Systems	Total Annual	Capital	Annual O&M
Denitrification w/ Pumping	379,196	1,989,648	379,196

Point Sources	Total Annual	Capital	Annual O&M
Municipal	2,424,046	31,501,539	730,645
Industrial	611,642	5,736,257	121,229
Total	3,035,688	37,237,795	851,873

All Sources	Total Annual	Capital	Annual O&M
Total	36,759,010	232,243,063	15,093,444

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

The Blue Plains facility treats wastewater from Maryland, Virginia, and the District of Columbia. Thus, in Exhibit 39, NRT costs for the Blue Plains WWTF are allocated to each of the jurisdictions according to their corresponding percentage of flow treated by Blue Plains (see MWCOG, 2002). Costs for CSO controls in the District of Columbia are allocated to the District.

Exhibit 40 summarizes the capital, O&M, and total annual (i.e., annualized capital plus annual O&M) costs for each significant municipal and industrial facility in the watershed. Since Exhibit 40 shows facility-level costs, the costs for the Blue Plains WWTF are not distinguished by the jurisdictions it serves. The costs in the exhibit represent the total cumulative cost of achieving each tier, including cost-share funds that offset the cost of NRT at municipal facilities.

Note that Exhibit 40 does not include federal facilities that are in the watershed. Households in the watershed will not incur direct costs for these facilities and, therefore, they are excluded from analyses.

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Municipal Facilities										
Blue Plains[2]	DC0021199	$0	$0	$0	$53,000,000	$8,900,000	$12,267,766	$379,000,000	$13,400,000	$37,482,703
DC Combined Sewer Overflow	NA	$130,000,000	$0	$8,260,558	$130,000,000	$0	$8,260,558	$130,000,000	$0	$8,260,558
DC Subtotal		**$130,000,000**	**$0**	**$8,260,558**	**$183,000,000**	**$8,900,000**	**$20,528,323**	**$509,000,000**	**$13,400,000**	**$45,743,260**
Bridgeville	DE0020249	$3,187,400	$63,244	$239,875	$3,328,511	$74,132	$258,583	$4,246,599	$82,065	$317,392
Laurel	DE0020125	$0	$0	$0	$2,487,286	$155,049	$292,882	$3,115,256	$167,481	$340,114
Seaford	DE0020265	$0	$0	$0	$0	$1,346	$1,346	$1,636,850	$37,452	$128,158
DE Subtotal		**$3,187,400**	**$63,244**	**$239,875**	**$5,815,797**	**$230,527**	**$552,811**	**$8,998,705**	**$286,998**	**$785,664**
Aberdeen	MD0021563	$0	$0	$0	$0	$0	$0	$2,408,870	$31,281	$181,458
Aberdeen Proving Grounds-Aberdeen	MD0021237	$8,000,000	$159,146	$657,893	$8,000,000	$159,146	$657,893	$9,945,658	$177,594	$797,640
Annapolis	MD0021814	$0	$0	$0	$0	$0	$0	$5,882,960	$111,936	$478,700
Back River	MD0021555	$0	$0	$0	$10,000,000	$141,129	$764,564	$253,600,000	$5,141,129	$20,951,420
Ballenger Creek	MD0021822	$0	$0	$0	$0	$0	$0	$3,180,890	$68,203	$266,511
Bowie	MD0021628	$0	$0	$0	$0	$0	$0	$2,138,663	$39,949	$173,280
Broadneck	MD0021644	$0	$0	$0	$0	$0	$0	$3,180,890	$86,565	$284,873
Broadwater	MD0024350	$0	$0	$0	$0	$0	$0	$1,636,850	$29,571	$131,618
Brunswick	MD0020958	$2,000,000	$10,928	$135,615	$2,131,667	$26,158	$159,054	$2,953,049	$54,031	$238,135
Cambridge	MD0021636	$6,904,964	$137,789	$568,268	$7,172,685	$215,921	$663,090	$11,164,196	$323,912	$1,019,927
Celanese	MD0063878	$5,791,500	$116,260	$477,322	$5,966,672	$132,516	$504,499	$7,603,522	$161,265	$635,295
Centreville	MD0020834	$5,065,400	$101,583	$417,378	$5,201,789	$109,536	$433,834	$6,071,524	$122,276	$500,795
Chesapeake Beach	MD0020281	$0	$0	$0	$0	$0	$0	$1,320,322	$27,209	$109,522
Chestertown	MD0020010	$2,600,000	$51,782	$213,875	$2,750,556	$72,832	$244,311	$3,765,350	$95,782	$330,526
Conococheague	MD0063509	$0	$0	$0	$0	$1,696	$1,696	$2,447,471	$27,266	$179,850
Cox Creek	MD0021661	$0	$0	$0	$0	$28,172	$28,172	$6,654,980	$274,756	$689,650
Crisfield	MD0020001	$4,052,200	$80,139	$332,767	$4,212,200	$89,073	$351,676	$5,323,700	$112,586	$444,484
Cumberland	MD0021598	$0	$0	$0	$0	$58,071	$58,071	$6,654,980	$250,533	$665,428
Damascus	MD0020982	$0	$0	$0	$0	$830	$830	$1,443,845	$27,892	$117,906
Delmar	MD0020532	$1,686,000	$19,833	$124,944	$1,686,000	$19,833	$124,944	$2,459,029	$38,128	$191,433
Denton	MD0020494	$0	$0	$0	$0	$1,268	$1,268	$918,088	$15,878	$73,114

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Dorsey Run	MD0063207	$0	$0	$0	$0	$0	$0	$1,636,850	$33,574	$135,621
Easton	MD0020273	$0	$0	$0	$205,516	$29,520	$42,333	$2,614,386	$74,906	$237,896
Elkton	MD0020681	$6,000,000	$128,234	$502,295	$6,000,000	$129,486	$503,547	$7,907,057	$174,147	$667,100
Emmitsburg	MD0020257	$0	$0	$0	$0	$4,669	$4,669	$869,735	$25,569	$79,791
Federalsburg	MD0020249	$1,300,000	$29,282	$110,329	$1,300,000	$29,282	$110,329	$2,169,735	$41,099	$176,367
Frederick	MD0021610	$0	$0	$0	$266,204	$210,251	$226,847	$4,219,114	$374,508	$637,542
Freedom District	MD0021512	$0	$0	$0	$0	$0	$0	$2,215,865	$59,144	$197,288
Fruitland	MD0052990	$0	$0	$0	$141,111	$11,381	$20,178	$1,059,199	$29,895	$95,929
Georges Creek	MD0060071	$2,000,000	$40,709	$165,396	$2,122,222	$54,211	$186,517	$2,846,898	$79,406	$256,891
Hagerstown	MD0021776	$0	$0	$0	$266,204	$97,440	$114,036	$4,219,114	$276,630	$539,664
Havre De Grace	MD0021750	$0	$0	$0	$0	$0	$0	$1,594,389	$38,674	$138,073
Hurlock	MD0022730	$4,600,000	$103,378	$390,158	$4,769,862	$160,897	$458,266	$6,271,609	$193,076	$584,069
Indian Head	MD0020052	$676,000	$12,603	$54,747	$788,778	$19,317	$68,492	$1,416,748	$33,133	$121,458
Joppatowne	MD0022535	$0	$0	$0	$0	$0	$0	$1,063,147	$28,048	$94,328
Kent Island	MD0023485	$20,742,570	$415,470	$1,708,632	$20,742,570	$415,470	$1,708,632	$22,765,430	$451,692	$1,870,966
La Plata	MD0020524	$0	$0	$0	$0	$4,030	$4,030	$1,443,845	$29,970	$119,984
Leonardtown	MD0024767	$2,511,529	$50,596	$207,173	$2,641,307	$61,044	$225,712	$3,443,348	$78,751	$293,421
Little Patuxent	MD0055174	$0	$0	$0	$0	$0	$0	$10,515,080	$291,813	$947,359
Maryland City	MD0062596	$0	$0	$0	$0	$0	$0	$1,829,855	$22,344	$136,423
Maryland Correctional Institute	MD0023957	$0	$0	$0	$0	$0	$0	$1,339,622	$27,220	$110,736
Mattawoman	MD0021865	$19,479,986	$397,854	$1,612,303	$19,479,986	$397,854	$1,612,303	$28,065,016	$514,993	$2,264,662
Mount Airy	MD0022527	$0	$0	$0	$0	$0	$0	$1,328,042	$19,228	$102,023
Northeast River	MD0052027	$2,718,000	$53,912	$223,361	$2,718,000	$53,912	$223,361	$4,354,850	$71,294	$342,790
Parkway	MD0021725	$0	$0	$0	$0	$0	$0	$3,759,905	$98,699	$333,104
Patapsco	MD0021601	$200,000,000	$4,067,523	$16,536,207	$200,000,000	$4,067,523	$16,536,207	$229,043,560	$5,248,210	$19,527,569
Patuxent	MD0021652	$0	$0	$0	$0	$0	$0	$3,759,905	$77,129	$311,535
Perryville	MD0020613	$0	$0	$0	$0	$0	$0	$1,501,746	$23,358	$116,982
Pine Hill Run	MD0021679	$0	$0	$0	$0	$11,611	$11,611	$3,180,890	$97,071	$295,379
Piscataway	MD0021539	$0	$0	$0	$0	$0	$0	$12,445,130	$354,631	$1,130,503
Pocomoke City	MD0022551	$3,529,470	$200,000	$420,039	$3,695,539	$229,233	$459,626	$5,100,783	$260,371	$578,371

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Poolesville	MD0023001	$1,658,000	$33,147	$136,513	$1,658,000	$33,147	$136,513	$2,527,735	$56,178	$213,766
Princess Anne	MD0020656	$0	$0	$0	$0	$0	$0	$1,351,203	$17,650	$101,889
Salisbury	MD0021571	$23,550,000	$476,487	$1,944,675	$23,550,000	$495,600	$1,963,788	$27,695,915	$619,540	$2,346,199
Seneca Creek	MD0021491	$29,520,000	$566,020	$2,406,398	$29,520,000	$611,888	$2,452,266	$38,105,030	$982,954	$3,358,552
Snow Hill	MD0022764	$1,600,000	$32,017	$131,767	$1,712,778	$44,864	$151,645	$2,340,748	$63,097	$209,027
Sod Run	MD0056545	$0	$0	$0	$0	$17,662	$17,662	$8,585,030	$266,222	$801,442
Talbot County Regional	MD0023604	$0	$0	$0	$0	$0	$0	$7,352,000	$154,586	$612,935
Taneytown	MD0020672	$0	$0	$0	$0	$5,741	$5,741	$1,289,441	$38,594	$118,982
Thurmont	MD0021121	$0	$0	$0	$0	$0	$0	$1,111,500	$31,478	$100,773
Western Branch	MD0021741	$0	$0	$0	$0	$0	$0	$0	$39,020	$39,020
Westminster	MD0021831	$0	$0	$0	$0	$0	$0	$2,794,880	$75,140	$249,382
MD Subtotal		**$355,985,619**	**$7,284,694**	**$29,478,054**	**$368,699,646**	**$8,252,218**	**$31,238,214**	**$807,889,172**	**$18,690,784**	**$69,057,357**
Addison (V)	NY0020320	$0	$0	$0	$2,423,823	$55,047	$210,528	$2,974,428	$64,674	$255,475
Bath (V)	NY0021431	$0	$0	$0	$2,882,193	$69,643	$254,528	$3,993,693	$95,930	$352,114
Binghamton-Johnson City Joint Borough	NY0024414	$0	$0	$0	$448,268	$175,305	$204,060	$9,033,298	$560,856	$1,140,316
Cooperstown	NY0023591	$0	$0	$0	$2,503,139	$59,398	$219,967	$3,150,451	$84,551	$286,643
Corning (C)	NY0025721	$0	$0	$0	$3,674,079	$92,485	$328,166	$5,361,111	$128,446	$472,346
Cortland (C)	NY0027561	$0	$0	$0	$0	$21,404	$21,404	$4,724,930	$197,711	$500,802
Elmira / Chemung Co. SD #2	NY0035742	$0	$0	$0	$9,940,841	$306,780	$944,457	$15,437,791	$453,234	$1,443,524
Endicott (V)	NY0027669	$0	$0	$0	$6,952,548	$264,880	$710,866	$6,952,548	$305,815	$751,801
Hamilton (V)	NY0020672	$0	$0	$0	$2,764,035	$61,060	$238,365	$3,730,476	$76,967	$316,266
Hornell (C)	NY0023647	$0	$0	$0	$4,950,960	$143,886	$461,476	$7,359,830	$214,750	$686,862
Lake Street/Chemung County SD #1	NY0036986	$0	$0	$0	$8,463,821	$271,098	$814,028	$12,995,746	$419,040	$1,252,680
Norwich	NY0021423	$0	$0	$0	$3,722,631	$108,573	$347,369	$5,436,683	$182,064	$530,812
Oneonta (C)	NY0031151	$0	$0	$0	$4,950,960	$117,700	$435,290	$7,359,830	$188,494	$660,606
Owego #2	NY0025798	$0	$0	$0	$175,172	$16,282	$27,519	$1,812,022	$45,739	$161,975
Owego (V)	NY0029262	$0	$0	$0	$2,882,193	$66,970	$251,854	$3,993,693	$88,561	$344,744
Richfield Springs (V)	NY0031411	$0	$0	$0	$2,444,284	$48,320	$205,114	$3,168,960	$58,719	$261,999

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Sidney (V)	NY0029271	$0	$0	$0	$3,374,544	$107,065	$323,532	$4,895,591	$127,000	$441,038
Waverly (V)	NY0031089	$0	$0	$0	$2,606,072	$69,949	$237,121	$3,379,101	$107,394	$324,154
NY Subtotal		**$0**	**$0**	**$0**	**$65,159,566**	**$2,055,843**	**$6,235,642**	**$105,760,184**	**$3,399,944**	**$10,184,157**
Altoona City Authority-East	PA0027014	$0	$0	$0	$1,428,274	$184,710	$276,329	$9,758,274	$500,170	$1,126,136
Altoona City Authority-West	PA0027022	$0	$0	$0	$1,481,376	$188,463	$283,489	$13,011,376	$479,656	$1,314,298
Annville Township	PA0021806	$0	$0	$0	$2,548,725	$51,066	$214,559	$3,418,460	$68,242	$287,526
Antrim Township	PA0080519	$0	$0	$0	$160,759	$7,913	$18,225	$1,430,899	$26,204	$117,992
Ashland MA	PA0023558	$0	$0	$0	$3,093,919	$75,810	$274,276	$4,460,562	$99,958	$386,090
Bedford Borough MA	PA0022209	$0	$0	$0	$2,860,429	$61,420	$244,909	$4,188,471	$95,308	$363,986
Bellefonte Borough	PA0020486	$0	$0	$0	$4,229,766	$81,123	$352,451	$6,337,548	$125,378	$531,914
Berwick MA	PA0023248	$0	$0	$0	$4,715,157	$137,740	$440,204	$6,988,924	$173,400	$621,720
Bloomsburg MA	PA0027171	$0	$0	$0	$4,935,313	$110,171	$426,757	$7,456,126	$171,969	$650,258
Blossburg	PA0020036	$0	$0	$0	$2,444,284	$49,624	$206,418	$3,168,960	$57,466	$260,746
Brown Township MA	PA0028088	$0	$0	$0	$2,444,284	$49,450	$206,244	$3,168,960	$61,882	$265,161
Burnham Borough	PA0038920	$0	$0	$0	$2,472,161	$52,432	$211,014	$3,235,520	$74,538	$282,088
Carlisle Borough	PA0026077	$0	$0	$0	$6,660,935	$136,597	$563,877	$10,227,835	$192,078	$848,164
Carlisle Suburban Authority	PA0024384	$0	$0	$0	$0	$0	$0	$1,038,971	$21,947	$88,594
Chambersburg Borough	PA0026051	$6,400,000	$124,868	$535,409	$6,623,722	$194,641	$619,534	$6,623,722	$220,445	$645,338
Clarks Summit-S. Abington JA	PA0028576	$0	$0	$0	$3,583,756	$107,432	$337,319	$5,220,606	$171,843	$506,730
Clearfield	PA0026310	$0	$0	$0	$5,072,176	$104,021	$429,386	$7,674,051	$158,103	$650,372
Columbia	PA0026123	$0	$0	$0	$3,408,584	$69,207	$287,858	$5,045,434	$89,924	$413,574
Curwensville MA	PA0024759	$0	$0	$0	$2,374,508	$51,188	$203,506	$3,002,478	$68,728	$261,329
Danville MA	PA0023531	$0	$0	$0	$4,229,766	$91,402	$362,729	$6,337,548	$144,517	$551,052
Derry Township MA	PA0026484	$0	$0	$0	$1,983,000	$120,430	$247,634	$3,223,000	$165,702	$372,448
Dillsburg Borough Authority	PA0024431	$0	$0	$0	$2,722,193	$55,091	$229,712	$3,833,693	$77,032	$322,953
Dover Township Sewer Authority	PA0020826	$0	$0	$0	$0	$11,171	$11,171	$2,408,870	$98,381	$252,903
Duncansville	PA0032883	$0	$0	$0	$3,035,449	$65,860	$260,575	$4,370,054	$86,837	$367,163
East Pennsboro South Treatment Plant	PA0038415	$0	$0	$0	$4,748,933	$140,287	$444,917	$7,042,000	$198,298	$650,022

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Eastern Snyder County Regional Auth	PA0110582	$3,000,000	$61,856	$254,297	$3,187,310	$104,746	$309,203	$3,187,310	$113,409	$317,866
Elizabethtown Borough	PA0023108	$4,083,001	$86,431	$348,344	$4,083,001	$86,431	$348,344	$6,105,861	$142,054	$533,727
Elkland MA	PA0113298	$0	$0	$0	$2,409,411	$47,203	$201,760	$3,085,734	$63,310	$261,251
Emporium Borough (Mid-Cameron Authority)	PA0028631	$0	$0	$0	$2,503,139	$56,125	$216,694	$3,150,451	$74,822	$276,914
Ephrata Borough WWTP	PA0027405	$0	$0	$0	$4,613,914	$105,209	$401,178	$6,945,582	$171,283	$616,822
Fairview Township	PA0081868	$0	$0	$0	$2,374,508	$47,883	$200,201	$3,002,478	$62,016	$254,617
Franklin County Authority-Greencastle	PA0020834	$0	$0	$0	$2,304,611	$46,741	$194,575	$2,835,875	$87,706	$269,619
Gettysburg MA	PA0021563	$0	$0	$0	$0	$0	$0	$1,494,026	$40,756	$136,594
Greater Hazelton	PA0026921	$0	$0	$0	$7,840,000	$163,170	$666,083	$24,090,000	$586,537	$2,131,842
Gregg Township	PA0114821	$0	$0	$0	$0	$1,822	$1,822	$918,088	$25,596	$84,489
Hampden Township	PA0028746	$0	$0	$0	$0	$641	$641	$1,544,208	$38,981	$138,037
Hampden Township SA	PA0080314	$0	$0	$0	$3,747,289	$73,618	$313,996	$5,577,144	$120,181	$477,938
Hanover Borough	PA0026875	$0	$0	$0	$60,000	$0	$3,849	$5,190,000	$181,365	$514,289
Harrisburg SA	PA0027197	$22,682,000	$865,000	$2,319,985	$22,682,000	$947,263	$2,402,248	$22,682,000	$1,089,046	$2,544,031
Highspire	PA0024040	$0	$0	$0	$3,408,584	$74,472	$293,123	$5,045,434	$104,127	$427,777
Hollidaysburg Regional	PA0043273	$0	$0	$0	$3,408,584	$84,480	$303,130	$5,045,434	$168,669	$492,319
Houtzdale Borough Municipal	PA0046159	$0	$0	$0	$0	$0	$0	$434,558	$5,125	$33,001
Huntingdon Borough	PA0026191	$0	$0	$0	$4,580,956	$99,010	$392,865	$6,893,324	$149,919	$592,106
Hyndman Borough	PA0020851	$0	$0	$0	$2,097,017	$42,091	$176,609	$2,342,031	$48,261	$198,495
Jersey Shore Borough	PA0028665	$0	$0	$0	$2,724,589	$85,654	$260,428	$3,642,677	$111,308	$344,976
Kelly Township MA	PA0028681	$0	$0	$0	$0	$0	$0	$1,926,358	$42,475	$166,045
Lackawanna River Basin SA	PA0027065	$0	$0	$0	$6,034,411	$133,365	$520,455	$9,215,301	$187,093	$778,228
Lackawanna River Basin SA	PA0027081	$2,513,941	$55,025	$216,287	$2,513,941	$55,521	$216,784	$3,335,323	$73,517	$287,468
Lackawanna River Basin SA	PA0027090	$0	$0	$0	$6,660,935	$128,655	$555,935	$13,580,935	$309,619	$1,180,797
Lancaster Area SA	PA0042269	$4,249,333	$93,253	$365,835	$4,249,333	$93,253	$365,835	$14,709,333	$293,204	$1,236,766
Lancaster City	PA0026743	$1,077,000	$8,461	$77,547	$1,077,000	$8,461	$77,547	$24,157,000	$620,831	$2,170,434
Lebanon City Authority	PA0027316	$0	$0	$0	$4,039,000	$139,109	$398,199	$11,659,000	$336,057	$1,083,948
Lemoyne Borough MA	PA0026441	$0	$0	$0	$3,468,413	$77,654	$300,143	$5,139,232	$123,963	$453,630

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Lewisburg Area JSA	PA0044661	$3,693,297	$75,717	$312,631	$3,693,297	$78,960	$315,874	$7,323,297	$136,768	$606,537
Lewistown Borough	PA0026280	$0	$0	$0	$3,679,787	$80,393	$316,441	$5,471,041	$131,005	$481,957
Lititz Sewage Authority	PA0020320	$0	$0	$0	$4,415,719	$94,250	$377,506	$6,631,584	$167,511	$592,908
Littlestown Borough	PA0021229	$0	$0	$0	$2,722,193	$57,995	$232,616	$3,833,693	$75,566	$321,486
Lock Haven	PA0025933	$4,580,956	$94,176	$388,031	$4,782,679	$123,736	$430,531	$9,372,679	$215,398	$816,628
Logan Township-Greenwood Area	PA0032557	$2,444,284	$49,316	$206,110	$2,566,507	$56,881	$221,515	$3,291,183	$70,668	$281,788
Lower Allen Township Authority	PA0027189	$0	$0	$0	$6,002,771	$136,328	$521,389	$9,164,360	$211,154	$799,021
Lower Lackawanna Valley	PA0026361	$0	$0	$0	$6,034,411	$141,695	$528,785	$9,215,301	$218,538	$809,673
Lykens Borough	PA0043575	$0	$0	$0	$2,311,606	$47,089	$195,372	$2,852,541	$57,051	$240,033
Mahanoy City	PA0070041	$0	$0	$0	$165,765	$11,192	$21,825	$1,563,289	$29,810	$130,091
Manheim Borough Authority	PA0020893	$0	$0	$0	$2,722,193	$57,468	$232,089	$3,833,693	$84,969	$330,889
Mansfield Borough	PA0021814	$0	$0	$0	$2,882,193	$64,115	$248,999	$3,993,693	$84,049	$340,233
Marietta-Donegal JA	PA0021717	$0	$0	$0	$2,444,284	$49,379	$206,172	$3,168,960	$66,373	$269,653
Martinsburg	PA0028347	$0	$0	$0	$2,374,508	$49,549	$201,867	$3,002,478	$65,572	$258,172
Marysville MA	PA0021571	$0	$0	$0	$2,374,508	$48,576	$200,894	$3,002,478	$85,887	$278,488
Mechanicsburg Borough Municipal	PA0020885	$0	$0	$0	$3,462,978	$67,602	$289,743	$5,130,708	$90,753	$419,874
Middletown	PA0020664	$0	$0	$0	$3,544,425	$72,505	$299,870	$5,258,477	$101,333	$438,649
Mifflinburg Borough Municipal	PA0028461	$0	$0	$0	$0	$0	$0	$639,575	$25,758	$66,785
Millersburg Borough Authority	PA0022535	$0	$0	$0	$2,722,193	$56,923	$231,544	$3,833,693	$81,131	$327,051
Millersville Borough	PA0026620	$0	$0	$0	$2,722,193	$56,514	$231,135	$3,833,693	$80,385	$326,305
Milton MA	PA0020273	$0	$0	$0	$3,814,671	$76,696	$321,396	$5,683,127	$112,144	$476,700
Montgomery Borough	PA0020699	$0	$0	$0	$2,566,507	$57,984	$222,618	$3,291,183	$77,453	$288,573
Moshannon Valley JSA	PA0037966	$0	$0	$0	$3,066,885	$62,920	$259,652	$4,510,730	$100,067	$389,418
Mount Joy	PA0021067	$0	$0	$0	$2,929,367	$56,610	$244,521	$4,296,010	$77,537	$353,114
Mount Union Borough	PA0020214	$0	$0	$0	$2,465,194	$50,502	$208,638	$3,218,882	$63,113	$269,595
Mountaintop Area	PA0045985	$0	$0	$0	$181,241	$64,537	$76,163	$1,972,495	$137,919	$264,449
Mt. Carmel Municipal Sewage Authority	PA0024406	$0	$0	$0	$3,234,471	$79,778	$287,260	$4,678,316	$109,540	$409,641
Mt. Holly Springs Borough Authority	PA0023183	$0	$0	$0	$2,444,284	$48,311	$205,104	$3,168,960	$61,362	$264,641

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Muncy Borough MA	PA0024325	$0	$0	$0	$2,998,186	$62,575	$254,900	$4,403,430	$83,305	$365,772
New Cumberland Borough Authority	PA0026654	$0	$0	$0	$2,894,913	$58,383	$244,083	$4,242,256	$72,483	$344,611
New Freedom WWTP	PA0043257	$0	$0	$0	$2,929,367	$61,546	$249,456	$4,296,010	$99,960	$375,537
New Holland Borough Authority	PA0021890	$0	$0	$0	$2,819,009	$58,751	$239,582	$4,123,890	$97,876	$362,411
New Oxford Municipal Facility	PA0020923	$0	$0	$0	$0	$0	$0	$942,264	$37,444	$97,888
Newberry Township	PA0083011	$0	$0	$0	$2,304,611	$48,327	$196,161	$2,835,875	$65,488	$247,402
Northeastern York Country	PA0023744	$0	$0	$0	$3,203,924	$66,014	$271,537	$4,724,971	$85,380	$388,473
Northumberland Borough	PA0020567	$0	$0	$0	$2,548,725	$51,570	$215,063	$3,418,460	$66,052	$285,336
Palmyra Borough Authority	PA0024287	$0	$0	$0	$3,011,935	$60,600	$253,807	$4,424,900	$86,841	$370,685
Penn Township	PA0037150	$0	$0	$0	$4,876,496	$97,677	$410,490	$7,362,568	$136,468	$608,755
Pine Creek MA	PA0027553	$0	$0	$0	$2,929,367	$62,319	$250,230	$4,296,010	$83,751	$359,328
Pine Grove Borough Authority	PA0020915	$0	$0	$0	$2,566,507	$58,279	$222,914	$3,291,183	$75,241	$286,361
Porter Tower Joint MA	PA0046272	$0	$0	$0	$0	$1,395	$1,395	$560,276	$24,286	$60,226
Roaring Spring Borough	PA0020249	$0	$0	$0	$0	$3,041	$3,041	$821,382	$27,964	$80,653
Sayre	PA0043681	$0	$0	$0	$3,367,738	$68,131	$284,162	$4,981,427	$83,309	$402,854
Scranton Sewer Authority	PA0026492	$0	$0	$0	$0	$85,177	$85,177	$11,673,110	$341,203	$1,089,999
Shamokin-Coal Township JSA	PA0027324	$0	$0	$0	$6,660,935	$163,547	$590,827	$10,227,835	$240,030	$896,117
Shenandoah Municipal SA	PA0070386	$0	$0	$0	$3,408,584	$69,167	$287,818	$5,045,434	$96,397	$420,047
Shippensburg Borough Authority	PA0030643	$0	$0	$0	$3,915,519	$80,883	$332,053	$5,841,877	$127,231	$501,970
Silver Spring Township	PA0083593	$0	$0	$0	$2,374,508	$47,610	$199,928	$3,002,478	$52,918	$245,519
South Middleton Township MA	PA0044113	$0	$0	$0	$2,548,725	$51,419	$214,912	$3,418,460	$65,314	$284,599
Springettsbury Township	PA0026808	$0	$0	$0	$0	$29,686	$29,686	$6,654,980	$256,095	$682,993
St. Johns	PA0046388	$0	$0	$0	$0	$185	$185	$724,676	$12,242	$58,727
Stewartstown Borough	PA0036269	$0	$0	$0	$2,304,611	$47,231	$195,066	$2,835,875	$58,511	$240,424
Sunbury City MA	PA0026557	$3,000,000	$63,044	$255,485	$3,197,930	$102,080	$307,218	$5,697,930	$182,367	$547,873
Swatara Township	PA0026735	$2,000,000	$32,982	$161,276	$2,000,000	$50,767	$179,062	$7,659,000	$123,800	$615,103
Towanda MA	PA0034576	$0	$0	$0	$160,000	$9,298	$19,562	$1,271,500	$32,968	$114,531
Tri-Boro MA	PA0023736	$0	$0	$0	$2,374,508	$47,736	$200,054	$3,002,478	$58,834	$251,434
Twin Boroughs SA	PA0023264	$0	$0	$0	$2,444,284	$50,110	$206,903	$3,168,960	$63,114	$266,393

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Tyrone Borough SA	PA0026727	$0	$0	$0	$0	$0	$0	$4,338,920	$99,159	$377,488
University Area JA	PA0026239	$780,000	$6,986	$57,021	$780,000	$6,986	$57,021	$1,300,000	$27,584	$110,975
Upper Allen Township	PA0024902	$0	$0	$0	$2,360,538	$50,070	$201,492	$2,969,167	$72,010	$262,474
Washington Township Municipal	PA0080225	$0	$0	$0	$160,000	$15,254	$25,518	$1,271,500	$47,511	$129,074
Waynesboro Borough	PA0020621	$0	$0	$0	$3,297,563	$120,030	$331,559	$4,776,149	$151,312	$457,689
Wellsboro MA	PA0021687	$0	$0	$0	$3,408,584	$73,375	$292,026	$5,045,434	$106,804	$430,455
Western Clinton County MA	PA0043893	$0	$0	$0	$0	$0	$0	$1,014,794	$12,018	$77,114
White Deer Township	PA0020800	$0	$0	$0	$2,423,823	$52,083	$207,564	$2,974,428	$63,250	$254,051
Williamsport SA-Central	PA0027057	$6,330,000	$137,056	$543,107	$6,634,134	$288,286	$713,846	$16,244,134	$545,016	$1,587,030
Williamsport SA-West	PA0027049	$5,246,000	$112,263	$448,779	$5,459,102	$184,866	$535,052	$15,219,102	$375,425	$1,351,686
Wyoming Valley	PA0026107	$0	$0	$0	$0	$71,004	$71,004	$24,690,000	$601,947	$2,185,739
York City	PA0026263	$0	$0	$0	$0	$0	$0	$11,080,000	$171,126	$881,876
PA Subtotal		**$72,079,813**	**$1,866,433**	**$6,490,146**	**$352,016,372**	**$9,203,774**	**$31,784,614**	**$670,716,278**	**$16,928,086**	**$59,952,609**
Alexandria	VA0025160	$0	$0	$0	$0	$0	$0	$21,709,370	$521,155	$2,104,456
Alleghany Co. Lower Jackson	VA0090671	$0	$0	$0	$3,234,471	$126,119	$362,014	$4,678,316	$149,719	$490,917
Aquia	VA0060968	$8,000,000	$160,000	$743,453	$8,000,000	$160,000	$743,453	$12,000,000	$195,000	$1,070,180
Arlington	VA0025143	$0	$0	$0	$0	$0	$0	$16,305,230	$489,067	$1,678,235
Ashland	VA0024899	$2,415,700	$45,093	$221,274	$2,590,872	$67,818	$256,774	$2,590,872	$76,193	$265,150
Broad Run WRF	VA_BROADR	$7,500,000	$149,148	$696,135	$13,500,000	$159,069	$1,143,646	$18,224,930	$195,753	$1,524,928
Buena Vista	VA0020991	$0	$0	$0	$3,757,275	$90,102	$364,127	$5,490,628	$129,571	$530,012
Cape Charles	VA0021288	$0	$0	$0	$2,288,710	$48,501	$215,420	$2,674,915	$55,864	$250,950
Caroline County Regional	VA0073504	$0	$0	$0	$2,487,286	$55,063	$236,464	$3,115,256	$62,753	$289,954
Clifton Forge	VA0022772	$0	$0	$0	$3,583,756	$85,609	$346,979	$5,220,606	$120,531	$501,278
Colonial Beach	VA0026409	$90,000	$740	$7,304	$265,172	$16,310	$35,650	$3,625,172	$60,648	$325,038
Covington	VA0025542	$0	$0	$0	$4,273,345	$130,890	$442,552	$6,296,205	$175,535	$634,727
Crewe Stp	VA0020303	$0	$0	$0	$2,374,508	$47,295	$220,472	$3,002,478	$53,949	$272,925
Culpepper	VA0061590	$4,200,000	$82,381	$388,694	$4,200,000	$93,433	$399,746	$6,801,875	$145,678	$641,750
Dahlgren (Dahlgren Sanitary District)	VA0026514	$0	$0	$0	$30,000	$0	$2,188	$550,000	$13,469	$53,582

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs Capital	Tier 1 Costs O&M	Tier 1 Costs Annual Costs[1]	Tier 2 Costs Capital	Tier 2 Costs O&M	Tier 2 Costs Annual Costs[1]	Tier 3 Costs Capital	Tier 3 Costs O&M	Tier 3 Costs Annual Costs[1]
Dale City #1	VA0024724	$0	$0	$0	$0	$0	$0	$1,060,000	$24,433	$101,741
Dale City #8	VA0024678	$0	$0	$0	$0	$0	$0	$1,060,000	$22,724	$100,032
Doswell	VA0029521	$3,045,000	$57,875	$279,952	$3,205,000	$143,615	$377,361	$3,205,000	$149,018	$382,764
Falling Creek	VA0024996	$395,818	$2,206	$31,074	$395,818	$19,918	$48,786	$5,993,818	$457,439	$894,578
Farmville	VA0083135	$0	$0	$0	$181,241	$19,315	$32,533	$1,972,495	$45,297	$189,154
Fishersville	VA0025291	$0	$0	$0	$1,443,064	$50,295	$155,540	$3,979,086	$88,878	$379,079
FMC	VA0068110	$0	$0	$0	$0	$13,603	$13,603	$2,949,284	$87,018	$302,115
Fredericksburg	VA0025127	$0	$0	$0	$0	$5,819	$5,819	$2,215,865	$59,822	$221,429
Front Royal	VA0062812	$0	$0	$0	$50,000	$2,469	$6,116	$4,840,000	$117,049	$470,038
FWSA Opequon	VA0065552	$0	$0	$0	$0	$6,903	$6,903	$6,390,000	$276,733	$742,766
Gordonsville	VA0021105	$0	$0	$0	$2,809,462	$58,281	$263,180	$3,862,938	$78,043	$359,774
H.L. Mooney	VA0025101	$0	$0	$0	$0	$0	$0	$8,011,100	$267,500	$851,763
Harrisonburg-Rockingham (North River Regional)	VA0060640	$0	$0	$0	$0	$0	$0	$7,040,990	$232,712	$746,223
Haymount STP	VA0089125	$2,687,559	$53,319	$249,327	$2,687,559	$57,246	$253,254	$3,750,706	$90,365	$363,910
Henrico County	VA0063690	$0	$0	$0	$300,000	$500,000	$521,879	$25,300,000	$4,770,175	$6,615,346
Hopewell	VA0066630	$0	$0	$0	$58,300,000	$2,748,200	$7,000,116	$71,500,000	$4,351,500	$9,566,114
HRSD-Army Base	VA0081230	$0	$0	$0	$81,000,000	$209,819	$6,117,284	$88,813,010	$556,083	$7,033,363
HRSD-Boat Harbor	VA0081256	$0	$0	$0	$112,000,000	$229,125	$8,397,471	$122,515,080	$679,691	$9,614,920
HRSD-Chesapeake/Elizabeth	VA0081264	$0	$0	$0	$35,000,000	$338,604	$2,891,212	$45,129,070	$853,532	$4,144,871
HRSD-James River	VA0081272	$0	$0	$0	$27,300,000	$184,767	$2,175,802	$35,885,030	$579,518	$3,196,673
HRSD-Nansemond	VA0081299	$0	$0	$0	$13,100,000	$43,772	$999,177	$25,545,130	$440,573	$2,303,622
HRSD-VIP	VA0081281	$0	$0	$0	$10,000,000	$0	$729,317	$26,305,230	$687,846	$2,606,330
HRSD-Williamsburg	VA0081302	$0	$0	$0	$15,800,000	$0	$1,152,320	$25,350,055	$312,147	$2,160,968
HRSD-York	VA0081311	$17,700,000	$132,100	$1,422,990	$17,700,000	$166,896	$1,457,787	$24,354,980	$422,229	$2,198,479
Kilmarnock	VA0020788	$0	$0	$0	$2,248,904	$65,962	$229,978	$2,586,756	$79,166	$267,822
Lake Monticello STP	VA0024945	$0	$0	$0	$2,566,507	$57,176	$244,355	$3,291,183	$78,511	$318,542
Leesburg	MD0066184	$0	$0	$0	$0	$10,322	$10,322	$2,736,978	$77,501	$277,114
Lexington-Rockbridge Reg. STP	VA0088161	$0	$0	$0	$205,516	$14,863	$29,851	$2,614,386	$35,274	$225,946
Little Falls Run	VA0076392	$0	$0	$0	$0	$0	$0	$4,000,000	$37,207	$328,934

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Luray	VA0062642	$0	$0	$0	$0	$0	$0	$3,360,000	$86,100	$331,150
Lynchburg	VA0024970	$0	$0	$0	$54,478,612	$928,781	$4,901,997	$55,323,612	$2,022,802	$6,057,645
Massanutten Public Service STP	VA0024732	$0	$0	$0	$2,685,114	$57,618	$253,448	$3,554,849	$71,330	$330,591
Massaponax	VA0025658	$0	$0	$0	$0	$0	$0	$3,952,910	$92,755	$381,047
Mathews Courthouse	VA0028819	$0	$0	$0	$2,094,204	$42,093	$194,827	$2,335,350	$48,162	$218,483
Middle River	VA0064793	$0	$0	$0	$247,998	$54,207	$72,294	$3,737,696	$176,155	$448,751
Montross - Westmoreland	VA0072729	$0	$0	$0	$2,094,204	$41,914	$194,648	$2,335,350	$44,268	$214,589
Moores Creek-Rivanna Authority	VA0025518	$0	$0	$0	$11,614,484	$428,783	$1,275,847	$18,269,464	$666,666	$1,999,089
New Market STP	VA0022853	$0	$0	$0	$2,487,286	$55,524	$236,926	$3,115,256	$77,469	$304,670
Noman M. Cole Jr. Pollution Control Plant	VA0025364	$0	$0	$0	$0	$0	$0	$15,338,696	$415,696	$1,534,373
Onancock	VA0021253	$0	$0	$0	$2,288,710	$53,538	$220,458	$2,674,915	$64,858	$259,944
Orange	VA0021385	$3,066,885	$59,901	$283,574	$3,234,471	$71,827	$307,723	$4,678,316	$93,586	$434,783
Parham Landing WWTP	VA0088331	$0	$0	$0	$2,423,364	$48,416	$225,156	$3,119,028	$52,112	$279,588
Parkins Mill	VA0075191	$0	$0	$0	$272,172	$22,047	$41,897	$3,632,172	$96,504	$361,404
Proctors Creek	VA0060194	$0	$0	$0	$0	$0	$0	$1,500,000	$526,000	$635,397
Purcellville	VA0022802	$0	$0	$0	$160,000	$8,452	$20,121	$1,271,500	$16,531	$109,263
Reedville	VA0060712	$0	$0	$0	$2,248,904	$46,528	$210,544	$2,586,756	$48,551	$237,207
Remington Regional	VA0076805	$0	$0	$0	$0	$0	$0	$1,636,850	$16,220	$135,599
Richmond	VA0063177	$32,050,000	$618,255	$2,955,715	$32,050,000	$816,628	$3,154,088	$59,935,530	$1,617,308	$5,988,507
Round Hill WWTP	VA0026212	$0	$0	$0	$2,487,286	$51,922	$233,324	$3,115,256	$57,823	$285,024
SIL MRRS	VA0090263	$0	$0	$0	$0	$0	$0	$0	$0	$0
South Central	VA0025437	$7,800,000	$338,000	$906,867	$7,800,000	$391,448	$960,315	$12,100,000	$708,448	$1,590,921
South Wales STP	VA0080527	$2,622,367	$52,058	$243,311	$2,622,367	$55,596	$246,849	$3,594,610	$85,891	$348,052
Stony Creek STP	VA0028380	$0	$0	$0	$2,566,507	$54,061	$241,241	$3,291,183	$64,029	$304,060
Strasburg	VA0020311	$0	$0	$0	$278,111	$13,538	$33,821	$2,928,111	$72,663	$286,215
Stuarts Draft	VA0066877	$0	$0	$0	$0	$11,513	$11,513	$520,000	$34,588	$72,513
Tangier Island	VA0067423	$0	$0	$0	$2,169,205	$45,611	$203,814	$2,410,351	$49,119	$224,910
Tappahannock	VA0071471	$0	$0	$0	$0	$0	$0	$918,088	$13,372	$80,330
Totopotomoy	VA0089915	$0	$0	$0	$0	$20,668	$20,668	$2,794,880	$133,621	$337,456

Exhibit 40: Cumulative Point Source Facility Costs by Tier

		Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
Facility	NPDES	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Upper Occoquan SA	VA0024988	$0	$0	$0	$22,601,459	$1,272,000	$2,920,362	$22,601,459	$1,272,000	$2,920,362
Urbanna	VA0026263	$0	$0	$0	$2,169,205	$50,577	$208,781	$2,410,351	$59,150	$234,940
Warrenton	VA0021172	$0	$0	$0	$3,747,289	$74,015	$347,311	$5,577,144	$105,163	$511,913
Warsaw	VA0026891	$0	$0	$0	$2,328,485	$62,036	$231,857	$2,763,043	$71,873	$273,386
Waynesboro	VA0025151	$0	$0	$0	$3,705,516	$127,144	$397,394	$3,705,516	$142,355	$412,604
West Point	VA0075434	$0	$0	$0	$2,566,507	$58,492	$245,672	$3,291,183	$81,605	$321,636
Weyers Cave STP	VA0022349	$0	$0	$0	$2,487,286	$54,453	$235,855	$3,115,256	$70,135	$297,336
Widewater WWTP	VA0090387	$2,374,508	$47,445	$220,621	$2,487,286	$50,527	$231,929	$3,834,629	$66,693	$346,359
Wilderness Shores	VA0083411	$0	$0	$0	$3,007,691	$69,199	$288,555	$3,635,661	$90,618	$355,773
Woodstock	VA0026468	$0	$0	$0	$841,111	$21,141	$82,485	$3,491,111	$60,069	$314,682
VA Subtotal		**$93,947,837**	**$1,798,521**	**$8,650,293**	**$619,123,296**	**$11,187,478**	**$56,341,171**	**$953,000,102**	**$27,875,160**	**$97,379,045**
Berkeley County PSSD	WV0020061	$0	$0	$0	$2,803,451	$65,993	$216,696	$3,818,245	$87,127	$292,381
Berkeley County PSSD	WV0082759	$0	$0	$0	$3,826,474	$91,831	$297,527	$5,598,427	$116,742	$417,692
Charlestown	WV0022349	$0	$0	$0	$3,023,464	$72,361	$234,891	$4,351,506	$98,245	$332,165
Keyser	WV0024392	$0	$0	$0	$3,679,787	$75,198	$273,009	$5,471,041	$107,430	$401,532
Martinsburg	WV0023167	$0	$0	$0	$190,344	$42,604	$52,836	$2,213,204	$101,563	$220,536
Moorefield	WV0020150	$0	$0	$0	$2,566,506	$51,795	$189,761	$3,291,182	$52,335	$229,257
Petersburg	WV0021792	$0	$0	$0	$2,724,589	$66,531	$212,994	$3,642,677	$92,850	$288,666
Romney	WV0020699	$0	$0	$0	$2,487,286	$56,451	$190,158	$3,115,256	$74,353	$241,817
WV Subtotal		**$0**	**$0**	**$0**	**$21,301,901**	**$522,764**	**$1,667,872**	**$31,501,539**	**$730,645**	**$2,424,046**
Municipal Total		**$655,200,669**	**$11,012,892**	**$53,118,926**	**$1,615,116,578**	**$40,352,603**	**$148,348,647**	**$3,086,865,979**	**$81,311,617**	**$285,526,138**
Industrial Facilities										
Dupont-Seaford	DE0000035	$0	$0	$0	$0	$0	$0	$0	$0	$0
DE Subtotal		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Allen Family Foods	MD0067857	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bethlehem Steel Corporation-Sparrows Point	MD0001201	$0	$0	$0	$0	$0	$0	$0	$0	$0
Chemetals	MD0001775	$0	$0	$0	$0	$0	$0	$0	$0	$0
Congoleum	MD0001384	$0	$0	$0	$0	$0	$0	$398,764	$11,061	$45,153
Garden State Tanning	MD0053431	$0	$0	$0	$5,000,000	$400,000	$827,468	$10,000,000	$800,000	$1,654,936

Exhibit 40: Cumulative Point Source Facility Costs by Tier

		Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
Facility	NPDES	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
MD & VA Milk Producers	MD0000469	$0	$0	$0	$7,350,911	$181,548	$810,004	$7,840,242	$196,844	$867,134
Mettiki Coal D	MD0064149	$0	$0	$0	$0	$0	$0	$0	$0	$0
Upper Potomac River Commission	MD0021687	$0	$0	$0	$0	$0	$0	$0	$109,197	$109,197
W R Grace	MD0000311	$0	$0	$0	$0	$0	$0	$0	$0	$0
Westvaco Corporation-Luke	MD0001422	$0	$0	$0	$0	$0	$0	$0	$0	$0
MD Subtotal		**$0**	**$0**	**$0**	**$12,350,911**	**$581,548**	**$1,637,472**	**$18,239,006**	**$1,117,102**	**$2,676,421**
Appleton Paper Springmill	PA0008265	$0	$0	$0	$0	$0	$0	$0	$23,341	$23,341
Chloe Textiles Inc.	PA0009172	$0	$0	$0	$0	$0	$0	$406,239	$12,159	$46,890
Consolidated Rail Corporation-Enola	PA0009229	$0	$0	$0	$0	$0	$0	$0	$0	$0
Empire Kosher Poultry-Mifflintown	PA0007552	$0	$0	$0	$0	$0	$0	$1,315,629	$33,331	$145,808
Gold Mills Dyehouse	PA0008231	$0	$0	$0	$0	$0	$0	$805,777	$21,430	$90,319
Heinz Pet Foods	PA0009270	$0	$0	$0	$4,166,532	$126,991	$483,203	$4,812,532	$147,153	$558,594
Merck & Company	PA0008419	$0	$0	$0	$337,450	$58,179	$87,029	$337,450	$126,782	$155,631
National Gypsum Company-Milton Plant	PA0008591	$0	$0	$0	$0	$718	$718	$0	$2,393	$2,393
Osram Sylvania Products, Inc.	PA0009024	$0	$0	$0	$0	$0	$0	$0	$5,863	$5,863
Pennsylvania Fish & Boat Commission-Bellefonte	PA0040835	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pennsylvania Fish & Boat Commission-Benner Springs	PA0010553	$0	$0	$0	$0	$0	$0	$3,180,697	$102,575	$374,505
Pennsylvania Fish & Boat Commission-Pleasant Gap	PA0010561	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pennsylvania Fish & Boat Commission-Typlersville	PA0112127	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pennsylvania Fish & Boat Commission-Upper Spring	PA0044032	$0	$0	$0	$0	$0	$0	$0	$0	$0
P-H Glatfelter Company	PA0008869	$0	$0	$0	$4,905,080	$86,637	$505,990	$10,576,472	$256,021	$1,160,242
Pope & Talbot Wis Inc.	PA0007919	$0	$0	$0	$0	$0	$0	$1,502,717	$51,235	$179,708
Proctor & Gamble Paper Products	PA0008885	$0	$0	$0	$4,674,320	$142,312	$541,937	$7,424,503	$257,765	$892,513
Tyson Foods	PA0035092	$0	$0	$0	$4,039,977	$79,131	$424,523	$4,716,300	$97,263	$500,476

Exhibit 40: Cumulative Point Source Facility Costs by Tier

		Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
Facility	NPDES	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
PA Subtotal		**$0**	**$0**	**$0**	**$18,123,358**	**$493,968**	**$2,043,399**	**$35,078,315**	**$1,137,311**	**$4,136,284**
Allied Signal-Hopewell	VA0005291	$0	$0	$0	$0	$0	$0	$0	$0	$0
Amoco-Yorktown	VA0003018	$0	$0	$0	$0	$0	$0	$0	$0	$0
Brown & Williamson	VA0002780	$0	$0	$0	$0	$5,173	$5,173	$942,156	$34,534	$115,083
BWXT	VA0003697	$0	$0	$0	$0	$0	$0	$0	$2,588	$2,588
Dupont-Spruance	VA0004669	$0	$0	$0	$0	$0	$0	$0	$0	$0
Dupont-Waynesboro	VA0002160	$0	$0	$0	$0	$0	$0	$0	$0	$0
Georgia Pacific Corporation	VA0003026	$0	$0	$0	$254,176	$386,421	$408,151	$254,176	$425,365	$447,095
Hoechst Celanese	VA0003387	$0	$0	$0	$0	$0	$0	$0	$0	$0
Lees Commercial Carpet	VA0004677	$0	$0	$0	$2,000,000	$0	$170,987	$2,000,000	$0	$170,987
Merck & Company Inc.-Stonewall Plant-Elkton	VA0002178	$0	$0	$0	$0	$0	$0	$800,000	$54,503	$122,898
Phillip Morris-Park 500	VA0026557	$0	$0	$0	$3,500,000	$1,300,000	$1,599,228	$11,500,000	$3,200,000	$4,183,177
Pilgrims Pride-Hinton	VA0002313	$0	$0	$0	$5,442,689	$247,682	$712,998	$6,109,177	$268,481	$790,776
Rocco Farm Foods-Edinburg	VA0077402	$0	$0	$0	$3,848,000	$0	$328,979	$3,848,000	$0	$328,979
Rocco Quality Foods	VA0001791	$0	$0	$0	$0	$0	$0	$0	$0	$0
St. Laurent Paper	VA0003115	$0	$0	$0	$0	$35,786	$35,786	$0	$135,464	$135,464
Tyson Foods, Inc.	VA0004031	$0	$0	$0	$0	$0	$0	$150,000	$1,200	$14,024
Tyson Foods, Inc.-Temperanceville	VA0004049	$0	$0	$0	$6,500	$150,000	$150,556	$631,500	$195,625	$249,614
Wampler Foods-Timberville	VA0002011	$0	$0	$0	$0	$0	$0	$0	$0	$0
Westvaco Corporation-Covington Hall	VA0003646	$0	$0	$0	$0	$0	$0	$12,340,085	$307,945	$1,362,943
VA Subtotal		**$0**	**$0**	**$0**	**$15,051,365**	**$2,125,063**	**$3,411,858**	**$38,575,094**	**$4,625,704**	**$7,923,629**
Hester Industries, Inc.	WV0047236	$0	$0	$0	$0	$0	$0	$0	$0	$0
Republic Paperboard	WV0005517	$0	$0	$0	$0	$0	$0	$0	$0	$0
Specratech International, Inc.	WV0005533	$0	$0	$0	$5,286,279	$107,156	$559,099	$5,736,257	$121,229	$611,642
Virginia Electric & Power Co.	WV0005525	$0	$0	$0	$0	$0	$0	$0	$0	$0
Wampler-Longacre, Inc.	WV0005495	$0	$0	$0	$0	$0	$0	$0	$0	$0
WV Subtotal		**$0**	**$0**	**$0**	**$5,286,279**	**$107,156**	**$559,099**	**$5,736,257**	**$121,229**	**$611,642**
Industrial Total		**$0**	**$0**	**$0**	**$50,811,912**	**$3,307,735**	**$7,651,829**	**$97,628,672**	**$7,001,346**	**$15,347,975**

Exhibit 40: Cumulative Point Source Facility Costs by Tier

Facility	NPDES	Tier 1 Costs			Tier 2 Costs			Tier 3 Costs		
		Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]	Capital	O&M	Annual Costs[1]
Grand Total		**$655,200,669**	**$11,012,892**	**$53,118,926**	**$1,665,928,490**	**$43,660,338**	**$156,000,476**	**$3,184,494,651**	**$88,312,963**	**$300,874,113**

1. Costs for municipal facilities are annualized at 2.4% for DC, 1.0% for DE, 2.2% for MD, 2.5% for NY, 3.9% for VA, and 0.7% for WV over 20 years. Industrial costs are annualized at 5.76% over 20 years.
2. Costs for Blue Plains are for the total facility and will be shared by the states of Maryland and Virginia, and the District of Columbia.

4. References

Aust, W.M., R.M. Schaffer, and J.A. Burger. 1996. Benefits and Costs of Forestry Best Management Practices in Virginia. Southern Journal of Applied Forestry 20(1): 23-29. Cited in U.S. EPA, 2001b.

Austin City Connection. 2001. Septic Tank/Wetland/Mound System. Online at http://www.ci.austin.tx.us/wri/treat17.htm.

BLUE Land, Water, Infrastructure. 1999. Creative Storm Water Control Techniques Save Land Developer $175,000 and Improve Water Quality. http://www.blwi.com/n_fall99.htm

Brown, W., and T. Schueler. 1997. The Economics of Storm water BMPs in the Mid-Atlantic Region. Final Report prepared by the Center for Watershed Protection (CWP) for the Chesapeake Research Consortium. As cited in CWP. (no date). The Economics of Storm Water Treatment: An Update. Technical Note #90 from Watershed Protection Techniques 2(4): 395-499.

Camacho, 1992. Chesapeake Bay Program Nutrient Reduction Strategy Reevaluation – Report #8. Financial cost-effectiveness of point and nonpoint source nutrient reduction technologies in the Chesapeake Bay basin. CBP/TRS 84/93; ICPRB report 92-4.

CAST. 1998. Workshop on Carbon Sequestration in Soils. News Release at www.cast-science.org/9812carb.htm.

Center for Watershed Protection (CWP). 1998. Cost and Benefit of Storm Water BMPs. Final Report prepared for Parsons Engineering Science.

Chesapeake Bay Program Modeling Subcommittee. 2000. Chesapeake Bay Watershed Model Land Use and Model Linkages to the Airshed and Estuarine Models. Annapolis, MD: January.

Chesapeake Bay Program Modeling Subcommittee. 1998. Chesapeake Bay Watershed Model Application and Calculation of Nutrient and Sediment Loadings. Appendix H: Tracking Best Management Practice Nutrient Reductions in the Chesapeake Bay Program.

Coffman, L. S. 2001. Reducing Nonpoint Pollution with Public Outreach/Education Programs (DRAFT- June 2001). Department of Environmental Resources, Prince George's County, Maryland.

Delaware Department of Agriculture. 2002a. "Nutrient Management Plan Cost-Share Program." Dover, DE. Online at http://www.state.de.us/deptagri/Services/farmer/nm_cs.htm.

Delaware Department of Agriculture. 2002b. "Nutrient Management Relocation Program." Dover, DE. Online at http://www.state.de.us/deptagri/Services/farmer/nm_reloc.htm.

EIA (Energy Information Agency). 2001. *Annual Energy Outlook 2002.* Washington, D.C.: U.S. Department of Energy, Energy Information Agency.

Environmental Law Institute. 2000. Forests for the Bay. A report in collaboration with and for the consideration of the Chesapeake Bay Commission, Chesapeake Bay Program, and USDA Forest Service. Washington, D.C.: Environmental Law Institute. ELI Document # d10.03.

Hairston-Strang, A. 2002. Maryland Cost Estimates for Riparian Forest Buffer Establishment. Memo from A. Hairston-Strang, Maryland Department of Natural Resources Forest Service to Allison Wiedeman, U.S. EPA. November 8.

Lichtenberg, Erik, James C. Hanson, A.M. Decker, and A.J. Clark. 1994. "Profitability of Legume Cover Crops in the Mid-Atlantic Region." *Journal of Soil and Water Conservation* 49(6): 582-585.

Lickwar, P., C. Hickman, and F. W. Cubbage. 1992. "Costs of Protecting Water Quality During Harvesting on Private Forestlands in the Southeast." Southern Journal of Applied Forestry 16(1): 13-20.

Livingston, E.H. 1999. "A Review of Urban Storm Water Retrofitting in Florida." In *Proceedings of the Comprehensive Storm Water & Aquatic Ecosystem Management Conference*, Auckland, New Zealand, February 22-26, 1999.

Mannering, J.V., D.R. Griffith, and K.D. Johnson. 1985. Cover Crops: Their Value and Management. West Lafayette, IN: Purdue University Cooperative Extension Service, Report AY-247. Online at http://www.agry.purdue.edu/ext/forages/publications/ay247.htm.

Maryland Department of Agriculture (MDA). 2002a. Maryland Agricultural Water Quality Cost Share (MACS) Program Average Cost of Animal Waste BMPs (BMP 313) Installed from 1997 to 2002. Information provided by J. Rhoderick, MDA Office of Resource Conservation.

Maryland Department of Agriculture (MDA). 2002b. Maryland Agricultural Water Quality Cost Share (MACS) Program Average Cost of Forest Buffers (BMP 391) Installed from 7/1/2001 to 6/30/2002. Information provided by J. Rhoderick, MDA Office of Resource Conservation.

Maryland Department of Agriculture (MDA). 2000. Cost-Share Assistance for Nutrient Management Plans. Maryland Department of Agriculture, Office of Resource Conservation.

Maryland Department of Environment (MDE). 1997. Watershed and Retrofit Assessments. Maryland Department of Environment, Water Management Administration.

Maryland Department of Natural Resources (MD DNR). 1999. The Forest Conservation Act: A Five Year Review.

Maryland Department of Natural Resources (MD DNR). 1996. Technical Appendix for Maryland's Tributary Strategies. March. Co-authored by Maryland Department of Environment, Maryland Department of Agriculture, Maryland Office of Planning, University of Maryland, and Office of the Governor.

Massachusetts Alternative Septic System Test Center (MASSTC). 2002. Technology Fact Sheet – Interim Findings, Amphidrome.

Massachusetts Alternative Septic System Test Center (MASSTC). 2001a. Technology Fact Sheet – Interim Findings, MicroFAST (Model 0.5).

Massachusetts Alternative Septic System Test Center (MASSTC). 2001b. Technology Fact Sheet – Interim Findings, Recirculating Sand Filter.

Nakao, M., B. Sohngen, L. Brown, and R. Leeds. 1999. The Economics of Vegetative Filter Strips. Columbus, OH: Ohio State University Extension. AE-0006-99. Online at http://ohioline.osu.edu/ae-fact/0006.html.

NAHB Research Center, Inc. and U.S. Environmental Protection Agency (U.S. EPA). 2001. Environmentally Green...Economically Green: Tools for a Green Land Development Program.

National Small Flows Clearinghouse (NSFC). 1998. Fact Sheet: Recirculating Sand Filters. WWFSOM25.Online at http://www.nesc.wvu.edu/nsfc/nsfc_etifactsheets.htm.

Natural Resources Defense Council (NRDC). 2001. Clean Water & Oceans: Water Pollution In-Depth Report. http://www.nrdc.org/water/pollution/storm/chap12.asp
in Low Impact Development in Puget Sound: Innovative Storm water Management Practices. http://www.wa.gov/puget_sound/Programs/lid_cd/abs_bio.pdf

New York Soil and Water Conservation Committee. No date. Request for Proposals: Agricultural Nonpoint Source Abatement and Control Program (ANPSACP). Round IX (proposals due January 2002) - Information for Applicants. Online through http://www.agmkt.state.ny.us/SoilWater/Projects.html.

North Carolina State University (NCSU). 1982. Best Management Practices for Nonpoint Source Control: Volume III, Sediment. Raleigh, NC: North Carolina Agricultural Extension Service, Biological and Agricultural Engineering Department, North Carolina State University.

Northern Virginia Planning District Commission (NVPDC). 1994. Urban Retrofit Techniques: Applicability, Costs, and Cost-Effectiveness. Prepared for Virginia Department of Environmental Quality.

Nutrient Reduction Technology (NRT) Cost Task Force. 2002. Nutrient Reduction Technology Cost Estimations for Point Sources in the Chesapeake Bay Watershed.

Palone, R.S. and A.H. Todd, eds. 1998. Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. USDA Forest Service. NA-TP-02-97. Radnor, PA. Online at www.chesapeakebay.net/.

Pelley, J. 1997. "The Economics of Urban Sprawl." *Watershed Protection Techniques* 2: 461-467. Citing Frank, J. 1989. *The Costs of Alternative Development Patterns: A Review of the Literature*. Washington, D.C.: The Urban Land Institute.

Pennsylvania Department of Environmental Protection (PA DEP). 2001. Fact Sheet: DEP Stream Bank Fencing Program – Landowner Participation. Commonwealth of Pennsylvania, Department of Environmental Protection. Online through http://www.dep.state.pa.us/farmers/.

Pennsylvania Department of Environmental Protection (PA DEP). 1998. Fact Sheet: Pennsylvania Chesapeake Bay Program – Landowner Participation in the Financial Assistance Funding Program. Commonwealth of Pennsylvania, Department of Environmental Protection. Online through http://www.dep.state.pa.us/farmers/.

Redman/Johnston Associates, Ltd. 1998. Who Pays for Sprawl? CBP/TRS 203/98. Prepared for the Chesapeake Bay Program's Land, Growth, and Stewardship Subcommittee and the Chesapeake Bay Local Government Advisory Committee.

Roberts, Roland K., James A. Larson, Donald D. Tyler, Bob N. Duck, and Kim D. Dillivan. 1998. "Economic Analysis of the Effects of Winter Cover Crops on No-Tillage Corn Yield Response to Applied Nitrogen." *Journal of Soil and Water Conservation* 53(3): 280-284.

Shulyer, L.R. 1995. "Cost Analysis for Nonpoint Source Control Strategies in the Chesapeake Basin. U.S. EPA, Chesapeake Bay Program. EPA 903-R-95-0005.

Tippett, John P., and Randall C. Dodd. 1995. Cost-Effectiveness of Agricultural BMPs for Nutrient Reduction in the Tar-Pamlico Basin. Research Triangle Institute. Report prepared for the North Carolina Dept. of Environmental, Health, and Natural Resources.

Turhollow, A. 2000. *Costs of Producing Biomass from Riparian Buffer Strips*. ORNL/TM-1999-146. Oak Ridge, TN: U.S. Department of Energy, Oak Ridge National Laboratory.

U.S. Department of Agriculture (USDA). 1999. CORE 4 Conservation Practices Training Guide. Washington, D.C.: USDA, Natural Resources Conservation Service.

U.S. Department of Agriculture, Economic Research Service (USDA-ERS). 2001. Table 2. Normalized Market-Clearing Price Estimates, National-Level Indices. Memorandum from S. Offutt to M. Gray, subject 2001 Normalized Prices.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 2002a. Conservation Reserve Program Monthly Contract Report: Practice Summary for Active CREP Contracts by Program Year. Online (by state) at http://www.fsa.usda.gov/crpstorpt/04approved/r7crepyr/r7crepyr2.htm.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 2002b. Conservation Reserve Program: West Virginia Enhancement Program. Washington, D.C.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 2002c. Pending Agreements – Conservation Reserve Enhancement Program 9/6/02. Online at http://www.fsa.usda.gov/dafp/cepd/crep/pending_ok.htm.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 2000a. Conservation Reserve Program: Virginia Enhancement Program. Washington, D.C.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 2000b. Conservation Reserve Program: Pennsylvania Enhancement Program. Washington, D.C.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 1999a. Conservation Reserve Program: Delaware Enhancement Program. Washington, D.C.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 1999b. Fact Sheet: Conservation Reserve Program. Washington, D.C.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 1997a. Conservation Reserve Program: Continuous Sign-Up for High Priority Conservation Practices. Washington, D.C.

U.S. Department of Agriculture, Farm Service Administration (USDA-FSA). 1997b. Conservation Reserve Program: Maryland Enhancement Program. Washington, D.C.

U.S. Department of Agriculture, National Agricultural Statistics Service (USDA-NASS). 1999. 1997 Census of Agriculture. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2002. Forestry Incentives Program (fact sheet for Virginia landowners). Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2001a. 2000 Environmental Quality Incentives Program: Delaware Summary. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2001b. 2000 Environmental Quality Incentives Program: Maryland Summary. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2001c. 2000 Environmental Quality Incentives Program: New York Summary. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2001d. 2000 Environmental Quality Incentives Program: Pennsylvania Summary. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2001e. 2000 Environmental Quality Incentives Program: Virginia Summary. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2001f. 2000 Environmental Quality Incentives Program: West Virginia Summary. Washington, D.C.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 1998. Conservation Practice Standard for Wetland Restoration (Code 657). Washington, D.C. August.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). No date. Fact Sheet: Wetlands Reserve Program. Washington, D.C. Online at http://www.nhq.nrcs.usda.gov/CCS/FB96OPA/WRPfact.html.

U.S. EPA. 2002. Onsite Wastewater Treatment Systems Manual. EPA-625-R-00-008. Washington, D.C.: U.S. EPA, Office of Water, Office of Research and Development.

U.S. EPA. 2001a. Cost Methodology Report for Beef and Dairy Animal Feeding Operations. EPA-821-R-01-019. Washington, D.C.: U.S. EPA, Office of Water.

U.S. EPA. 2001b. National Management Measures to Control Nonpoint Source Pollution from Forestry. Draft. Washington, D.C.: U.S. EPA, Office of Water. Prepared by Tetra Tech.

U.S. EPA. 2001c. Weighted Average Interest Rate for Clean Water SRF Assistance, by State. Office of Wastewater Management and Region 5 Water Division. Online at http://www.epa.gov/r5water/cwsrf/pdf/ratest.pdf.

U.S. EPA. 2000. Low Impact Development (LID): A Literature Review. EPA-841-B-00-005. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water.

U.S. EPA. 1999a. Decentralized Onsite Management for Treatment of Domestic Wastes - Septic Tanks.

U.S. EPA. 1999b. Economic Analysis of the Final Phase II Storm Water Rule. Washington, D.C.: U.S. EPA, Office of Water.

U.S. EPA. 1998. Preliminary Data Summary of Urban Storm Water Best Management Practices. Washington, D.C.: U.S. EPA, Office of Water, Office of Science and Technology.

U.S. EPA. 1997a. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. EPA-840-B-93-001c January 1993/revised January 21, 1997. http://www.epa.gov/OWOW/NPS/MMGI/index.html.

U.S. EPA. 1997b. Response to Congress on Use of Decentralized Wastewater Treatment Systems. EPA 832-R-97-001b. Washington, D.C.: U.S. EPA, Office of Water, Office of Wastewater Management.

U.S. EPA. 1996. Green Development: Literature Summary and Benefits Associated with Alternative Development Approaches. EPA 841-B-97-001. Washington, D.C.: U.S. Environmental Protection Agency, Office of Water.

U.S. Federal Reserve Board. 2002a. Federal Reserve Statistical Release E.2: Survey of Terms of Business Lending, February 4-8, 2002. Washington, D.C.: Federal Reserve. Online at http://www.federalreserve.gov/releases/e2/.

U.S. Federal Reserve Board. 2001a. Federal Reserve Statistical Release E.2: Survey of Terms of Business Lending, February 5-9, 2001. Washington, D.C.: Federal Reserve. Online at http://www.federalreserve.gov/releases/e2/.

U.S. Federal Reserve Board. 2000a. Federal Reserve Statistical Release E.2: Survey of Terms of Business Lending, February 7-11, 2000. Washington, D.C.: Federal Reserve. Online at http://www.federalreserve.gov/releases/e2/.

U.S. Federal Reserve Board. 1999a. Federal Reserve Statistical Release E.2: Survey of Terms of Business Lending, February 1-5, 1999. Washington, D.C.: Federal Reserve. Online at http://www.federalreserve.gov/releases/e2/.

U.S. Federal Reserve Board. 1998a. Federal Reserve Statistical Release E.2: Survey of Terms of Business Lending, February 2-6, 1998. Washington, D.C.: Federal Reserve. Online at http://www.federalreserve.gov/releases/e2/.

Virginia Department of Conservation and Recreation (VA DCR). 2001. *Virginia Agricultural BMP Manual.* Richmond, VA.

Virginia Department of Environmental Quality. 1993. Discussion Paper: Reducing Nutrients in Virginia's Tidal Tributaries. May.

Virginia Secretary of Natural Resources (VA SNR). 2000. York River and Lower York Coastal Basins: Tributary Nutrient Reduction Strategy. February.

Walsh, M.E., and E. Lichtenberg. 1995. "Estimated Government Savings from Biomass Production on CRP Acres." In *Energy Crops Forum*. Online at bioenergy.ornl.gov/forum/95fall.html.

Wetland Science Institute. 2000. Evaluation of Reforestation in the Lower Mississippi River Alluvial Valley. Wetland Restoration Information Series Number 3. Laurel, MD: U.S. Department of Agriculture, Natural Resources Conservation Service, Wetland Science Institute. Online at HTTP://WWW.PWRC.USGS.GOV/WLI/wris3.htm.

Yeh, C., and B. Sohngen. 1999. Pennsylvania Buffer Templates: Grass and Legume Filter Strip Worksheets. Agricultural, Environmental, and Development Economics, Ohio State University. Online at http://www.ctic.purdue.edu/cgi-bin/WaterMap.exe?Map=buffermap420.map& US+Map.x=349&US+Map.y=99.

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Part II. Socioeconomic Impacts of the Tier Scenarios in the Chesapeake Bay Watershed

At the request of EPA's Chesapeake Bay Program, the EPA National Center for Environmental Economics (NCEE) evaluated the potential socioeconomic impact of developing revised water quality criteria, designated uses, and boundaries for the Chesapeake Bay and its tidal waters. NCEE estimated the direct and indirect effects of compliance using peer-reviewed economic models of the affected sectors in The Chesapeake Bay watershed. Economic and social impacts evaluated include changes in employment, wages, income, and the value of regional output, or goods produced.

1. BACKGROUND

The Chesapeake Bay Program developed revised water quality criteria, designated uses, and boundaries for the Chesapeake Bay and its tidal waters, as well as the *Technical Support Document* for jurisdictions to use when conducting use attainability analyses (UAA) to support these changes. Among the factors that the Chesapeake Bay Program is evaluating as part of the UAA is whether the refined designated uses would require pollution controls more stringent than those required under Sections 301(b)(1)(A) and (B) and Section 306 of the Clean Water Act (i.e., nutrient controls) which would result in substantial and widespread social and economic hardship in the Chesapeake Bay watershed. Although the Chesapeake Bay Program did not use economic factors in developing the revised uses, it is providing information on the potential costs and economic impacts for three level-effort-scenarios of pollution controls to meet these uses.

NCEE evaluated the socioeconomic impact of the tier scenarios on the Chesapeake Bay watershed region, including both the direct and indirect effects of compliance. Measures of economic impacts include changes in the value of regional output, or goods produced, employment, as well as wages and income. These measures are important to determining whether "widespread economic impacts" are present, as defined below and in EPA's Water Quality Standards Handbook (1995), referred to as the "guidance" hereafter.

EPA's guidance specifies three steps to determining whether impacts are expected to be widespread:

- **Step 1:** Define relevant geographic area;
- **Step 2:** Estimate socioeconomic changes due to pollution control costs; and
- **Step 3:** Consider the multiplier effect.

Geographic Area

The analysis must define the affected community (the geographic area where project costs pass through to the local economy), consider the baseline economic health of the community, and finally evaluate how the proposed project will affect the socioeconomic well-being of the community. Whereas the financial analysis to determine "substantial" impacts is conducted for each affected facility separately, the widespread analysis is conducted for all dischargers jointly (EPA, 1995). Since the Tier scenarios affect dischargers in a multi-state region, analysis of socioeconomic changes cannot ignore that expenditures will occur across this wide area (because a cost to one sector is revenue to another sector). Therefore, the relevant geographic area crosses state boundaries.

Estimate Socioeconomic Changes

Estimating the socioeconomic changes that will result from the pollution control costs involves first running a baseline scenario to forecast the conditions that would exist absent the expenditures, and then running a policy scenario to model the impact of the expenditures. The difference in magnitude of socioeconomic indicators such employment, unemployment, income, persons below the poverty line, and tax revenues are the impacts of the controls.

Multiplier Effects

When using economic models to estimate socioeconomic changes, the secondary effects of the control costs are also captured. These secondary effects reflect that each dollar spent in the economy on pollution control results in spending of more than one dollar in the economy (i.e., a multiplicative effect). Similarly, each dollar lost to an employee (i.e., through lost wages) would result in the loss of more than one dollar to the local economy.

2. METHOD

NCEE used two models to estimate the socioeconomic impacts of the tier scenarios. First, to obtain a baseline forecast for the six state area, NCEE used the Multi-Region Policy Insight model produced by Regional Economics Models, Inc. (REMI). The REMI model incorporates aspects of computable general equilibrium, input-output, and econometric forecasting models into one model that takes advantage of the relative strengths of each method. The REMI model features:

- 53 sectors
- 51 regions, including all states plus the District of Columbia
- A strong theoretical foundation which has been peer reviewed and demonstrated
- Forecasts for a large number of output variables including prices and incomes
- Flexibility in analyzing the timing of economic impacts
- Ability to accounts for business cycles, reducing error.

Then, NCEE used IMPLAN (Impact Analysis for Planning), produced by the Minnesota Implan Group, Inc.(MIG, 2001), to model the expenditures for pollution control. IMPLAN is an input-output model that, without further calibration, can produce state-level multipliers that are directly comparable to RIMS II multipliers.[1] IMPLAN data are compiled from state, local and national sources including:

- U.S. Bureau of Economic Analysis Benchmark I/O Accounts of the United States
- U.S. Bureau of Economic Analysis Output Estimates
- U.S. Bureau of Economic Analysis REIS Program
- U.S. Bureau of Labor Statistics ES202 Program
- U.S. Bureau of Labor Statistics Consumer Expenditure Survey
- U.S. Census Bureau County Business Patterns
- U.S. Census Bureau Decennial Census and Population Surveys
- U.S. Census Bureau Economic Censuses and Surveys
- U.S. Department of Agriculture
- U.S. Geological Survey.

The IMPLAN model features:

- 528 Industrial Sectors, typically at the 4 digit standard industrial classification level in manufacturing, 2 to 3 digit for other sectors

- All states and counties in the United States

- All elements balanced to the National Income and Product Accounts

- Conformity to I/O accounting definitions

- Modeling flexibility.

The IMPLAN system produces impact estimates measured in changes from the base year, assuming no other changes in the economy. In other words, the tier scenario impacts are estimated assuming that the costs and spending took place, but that the underlying structure of the economy remained the same. Thus, the estimated tier scenario impacts do not incorporate the changes in the baseline forecast shown below.

3. Baseline Forecast

Exhibit 1 provides the highlights of the baseline forecast for the state of Maryland, which is located entirely in the Chesapeake Bay watershed, through 2010. (The model was no longer available to NCEE at a later date to run baseline forecasts for other states.) The first column lists the values for the year 2000.

[1] The REMI and IMPLAN frameworks provide a more credible and theoretically sound basis for estimating socioeconomic impacts compared to the simple use of multipliers. In multiplier analysis, care must be taken to model both the cost and revenue impacts that will result from controls.

Exhibit 1: Macroeconomic Forecast, 2000–2020, Maryland
(percent growth over year 2000 values)

Factor	2000	2005	2010	2015	2020
GRP (Billions 1992 $)	158	187 (18.6)	217 (37.1)	243 (53.7)	268 (69.5)
Employment (Thousands)	3,106	3445 (10.9)	3,863 (18.6)	3,818 (23.0)	3,932 (26.6)
– Percent of U.S.	1.8 %	1.9 (5.6)	2.0 (9.5)	2.0 (10.1)	2.0 (10.6)
Population (Thousands)	5,238	5,599 (6.8)	6,051 (15.5)	6,441 (23.0)	6,780 (29.4)
RDPI per cap (Thousands 1992 $)	23.4	25.6 (9.2)	27.5 (17.1)	28.8 (22.7)	30.2 (28.7)
Manufacturing Employment (Thousands)	187.7	183.2 (–2.4)	180.9 (–3.6)	184.0 (-2.0)	187.8 (0.0)
Non-Manufacturing Employment (Thousands)	2,374.8	2,674.4 (12.6)	2,882.1 (21.5)	2,991.3 (26.0)	3,087 (30.0)
Farm Employment (Thousands)	17.9	16.2 (-9.8)	14.8 (-17.5)	14.1 (–21.5)	13.4 (–25.4)

GRP = Gross regional product
RDPI = Real disposable per capita income

The REMI model forecasts that the Maryland economy will grow through 2020. In 2010, gross regional product (GRP) is projected to be 37.1% higher than in 2000. Employment will also grow. In 2010, Maryland will have 18.6% more workers than in 2000. Compared to the rest of the United States, the exhibit shows that in 2000 Maryland employed 1.8% of the nation's workers, and by 2010, this percentage is expected to grow by 9.5% (i.e., in 2010, MD will have 2.0% of the nation's workers). Population, at 5.2 million in 2000, will grow by 15% by 2010. People will be better off, as shown by real disposable personal income (RDPI), which is forecast to expand by 17.1% by 2010.

The economy in the future will continue to evolve. The last three rows of Exhibit 1 show employment in various sectors. Manufacturing and farm employment will decrease by 3.6% and 17.5%, respectively, while non-manufacturing will continue to expand by 21.5% by the year 2010. Also, by 2020, most of manufacturing jobs have returned, but farm jobs continue to disappear.

4. Impact of Tier Scenarios

To estimate the impact of the tier scenarios, NCEE modeled the tier cost estimates are using IMPLAN.

4.1 Modeling Assumptions

Exhibit 2 shows the estimated annual costs and spending patterns resulting from the Tier 3 scenario.[2] These data appear different from those presented in Part I because these data are presented by payer or payee, rather than by sector. For example, households are assumed to pay for POTW improvements as well as urban and mixed open nonpoint programs, state-funded portions of agricultural cost sharing, and septic system improvements. Similarly, the water supply and sewerage systems sector is assumed to receive money spent for POTW improvements as well as urban and mixed open nonpoint controls and industrial sector upgrades. This summary, in reducing some of the sector-level data to simple "payer" and "payee" groups, illustrates some of the important distributional effects of the Tier 3 scenario.

The total spending amount of $1,135 million exceeds the cost total of $945 million by about $190 million, representing the flow of federal dollars into the region as a result of the Tier 3 scenario. While in reality the taxpayers of the region would pay some of this cost through federal taxes, the federal government has a much larger population and more flexibility in budgeting than the states have. NCEE assumed that the federal budget is exogenous.

Exhibit 2 shows that households (i.e., the public) are the largest paying sector, with approximately $802 million in expenditures in 2010 under Tier 3 for POTW improvements as well as urban and mixed open nonpoint programs. The agriculture and forestry (private) sectors combined face approximately $128 million in costs, and the industrial sector faces $15 million in costs. Water supply and sewerage systems is the largest payee sector, receiving about $715 million in spending for POTW improvements, urban and mixed open nonpoint programs, and industrial improvements. The agricultural services sector receives approximately $407 million for agricultural and forest BMPs, and the residential maintenance and repair sector receives approximately $13 million for onsite wastewater management system improvements.

To model the pollution control expenditures, the costs are translated into changes in economic variables for the affected sectors.

POTWs

The POTW sector will face increased cost of treatment, in the form of capital and O&M expenditures. Some of these costs are paid by state and federal funds. Based on the assumptions developed by the UAA workgroup and presented elsewhere in this document, capital cost shares of 50% are expected in MD and 10% in VA; facilities in all other states pay capital cost in entirety. NCEE modeled these cost shares in IMPLAN as coming from state sources.

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[2] Tier 1 and 2 show similar patterns, but with lower totals.

Exhibit 2. Estimated Incidence of Costs and Distribution of Spending, Tier 3[1]

Costs ("Payers")	State	Amount (millions of 2001 $)	Spending ("Payees")	State	Amount (millions of 2001 $)
Households	DE	5.694	**Water Supply and Sewerage**	DE	3.175
	DC	31.609		DC	31.576
	MD	221.609		MD	205.887
	NY	39.398		NY	31.766
	PA	187.087		PA	151.789
	VA	301.867		VA	280.339
	WV	14.889		WV	10.543
	Subtotal	*802.153*		*Subtotal*	*715.075*
Agriculture & Forestry	DE	2.159	**Agricultural Services**	DE	9.465
	DC	0		DC	0
	MD	4.262		MD	51.599
	NY	12.504		NY	32.817
	PA	53.529		PA	163.931
	VA	43.680		VA	123.388
	WV	11.529		WV	25.837
	Subtotal	*127.662*		*Subtotal*	*407.036*
Industry	DE	0	**Residential Repair**	DE	0.181
	DC	0		DC	0.033
	MD	2.676		MD	3.251
	NY	0		NY	1.132
	PA	4.136		PA	4.106
	VA	7.924		VA	3.944
	WV	0.612		WV	0.379
	Subtotal	*15.348*		*Subtotal*	*13.026*
Totals		**945.163**			**1,135.137**

1. Household costs include POTW improvements, urban and mixed open nonpoint programs, state-funded portions of agricultural cost sharing, and septic system improvements. Agriculture, forestry, and industrial sector costs include only the private costs for those sectors. The water supply and sewerage sector receives payments for POTW improvements, urban and mixed open nonpoint programs, and industrial improvements. The agricultural services sector receives payments for agriculture and forestry improvements. The residential repair sector receives payments for onsite wastewater management system improvements.

NCEE assumed revenue neutrality with respect to POTW costs, and modeled the costs as being passed on to residential customers through higher fees (for household shares) or taxes (for the state share in Maryland and Virginia). This revenue neutrality is accomplished by decreasing household consumption on other goods and services by an amount equal to the annual cost. On the revenue side, the economic impact of implementing POTW controls is modeled by increasing output of the water supply and sewerage systems sector by the same annual cost.

Industrial Facilities

Certain industries face increased cost of treatment under the various tiers. NCEE modeled these costs as a decrease in output. This approach implicitly assumes that these firms sell undifferentiated products to a competitive national or world market, which seems reasonable considering the industries represented. This also is a conservative approach. If on the other hand, firms hold a regional monopoly, the costs would come out of profits, not output, and employment effects would be minimal.

Water pollution control in the affected industries consists of procedures to remove nitrogen and phosphorous, not unlike the processes used by a sewage treatment plant. Therefore, the revenues generated from expenditures on controls fall to the sewage treatment sector input suppliers.

Agriculture

Agriculture will be responsible for a large portion of the control costs. However, the sector will receive a great deal of cost sharing from state and federal sources. Based on an analysis of the most recent legislative provisions, the distribution of public funds is approximately 68% federal, and 32% state. For the state, NCEE assumed revenue neutrality, meaning that costs are passed on to residents through higher taxes, and modeled the impact of increased taxes as a decrease in household consumption equal to the state portion of costs. Private sector (on-farm) costs are modeled as a decreased output of food grains.

The revenue impact of expanding agricultural BMPs is modeled by increasing output of agricultural services sector by the full costs of BMPs, including state and federal portions.

Forestry

The impact of forestry control costs is modeled by decreasing output in the forestry sector, and increasing revenues to the agricultural and forestry services sector.

Urban

NCEE modeled urban and mixed open land use control costs similarly to POTWs, but without cost sharing. Costs are assumed to be passed on to residents through higher fees (revenue neutrality), who compensate by reducing household expenditures on other goods and services. The expenditures boost the output of the water supply and sewerage systems sector.

Septic Systems

Many aging septic systems will be upgraded under Tier 3, and NCEE modeled the impact of these expenditures as a decrease in other household expenditures, and an increase in demand for the residential maintenance and repair (skilled labor category including plumbers and licensed contractors).

4.2 Results

Exhibits 3 through 23 provide the IMPLAN model results for each state and tier. The impact results are measured in terms of output, employment, and value added:

- ***Output*** means the dollar value of all goods and services produced in the state. Negative (positive) numbers mean reductions (increases) in output, that is, declining (increasing) gross regional product.

- ***Employment*** is the total effect on statewide employment, counting all direct and ripple effects.

- ***Value Added*** includes labor income, corporate income and indirect business taxes.

The rows in Exhibits 3 through 23 represent the sectors affected by specific control measures, and the column labeled Tier Costs represents the direct and "ripple" effects of these expenditures. For example, the total jobs figures under the Economic Impact sub-heading in the Tier Cost column represents the economy-wide employment impact in all sectors.

The column labeled Tier Spending shows the stimulus effect of program-related spending to implement the nutrient and sediment reduction actions. For example, the total jobs figure under the Economic Impact subheading in the Tier Spending column represents the number of additional jobs supported. In most instances, this number exceeds the number of jobs lost. However, a couple of caveats apply. First, the model assumes no supply constraints for labor or materials. These total impacts can only be realized if there are, in fact, workers available to take the positions and no other resource constraints are binding. The second caveat is that this is the long-term effect, and some time will be required before the spending impacts are fully realized.

There are distributional consequences associated with the scenarios. Overall, consumers bear most of the costs through higher taxes (for agricultural controls) or higher water and sewer fees, or both. Reductions in disposable income tend to concentrate cost impacts on the retail, restaurant, and service sectors. Spending impacts occur in many skilled professional and technical areas such as water treatment and agricultural services.

However, it should be emphasized that because of the small size of the impacts relative to the size of the sectors themselves, the true implications of these impacts are higher or lower growth, not absolute expansion or contraction. For example, in Maryland, the Tier 3 scenario results in a (gross) addition of 3,224 jobs and a loss of 3,172 jobs (for a net increase of 52 jobs). However, the baseline REMI forecast for Maryland indicates an estimated 757,000 more jobs in Maryland by 2010 (see Exhibits 1 and 19). Similarly, in Maryland's agriculture sector, the Tier 3 costs and spending totals of $17.418 million and $49.608 million, respectively, should be viewed in the context of the REMI baseline forecast that predicts 17.5% less agricultural employment by 2010 (see Exhibit 1). Although baseline REMI forecasts for the Chesapeake Bay watershed portions of other states are unavailable, NCEE expects the same kind of growth patterns to prevail throughout the region.

5. Summary

As could be expected, the fact that spending exceeds costs is translated into net positive impacts for all three tier scenarios. Moreover, in terms of macroeconomic variables such as employment and economic output that are important in determining widespread impacts, there is a slight gain in transferring dollars from consumers who largely purchase goods imported to the region, to local infrastructure development.

Given the size of the regional economy ($1.4 trillion in personal income in 1999 in the six-state area and the District of Columbia, including $574 billion in Chesapeake Bay counties; in 2001 dollars, the values are $1.5 trillion and $610 billion, respectively), net impacts over this area are not likely to be seen. For example, baseline gross regional product in the state of Maryland is forecast to grow by 37% by 2010, corresponding to 19% growth in employment and 17% growth in real disposable personal income. The Tier 3 scenario would result in a net increase in output, employment, and value added above baseline levels. The stimulus results from increased spending in high wage industries (e.g., wastewater treatment technologies) as well as an influx of funds for pollution controls (e.g., federal cost shares for agricultural BMPs). Not included are additional market benefits likely to result from improved water quality (e.g., commercial and recreational fishing industries). Therefore, the regional economy should expand as a result of the tier scenarios, but the changes will be nearly impossible to detect given the level of macroeconomic changes present in the baseline forecast.

The estimated annual cost of Tier 3 for 2010 populations ($1.1 billion in 2001 dollars) represents 0.2% of personal income in the Chesapeake Bay counties in 1999. Even if all capital costs ($7.9 billion) for this scenario were incurred in one year, they represent only 1.4% of personal income in the Chesapeake Bay counties in 1999. Although these data indicate that the pollution controls specified in the tier scenarios will not result in substantial and widespread social and economic hardship, there may be localized areas that need funding priority or special considerations.

Exhibit 3: Economic Impact, Tier 1, Delaware

	Tier 1 Costs		Tier 1 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduced Output $705,766	Total Output . . . ($1,099,214) Total Jobs . . . . (14.8) Value Added . . . . ($372,563)	Increased Output: Ag. Services $2,240,817	Total Output$ . . . . 3,324,039 Total Jobs . . . . 136.4 Value Added $1,929,972
Agriculture – public	Reduced Household Consumption $491,216	Total Output . . . . ($682,007) Total Jobs . . . . (8.5) Value Added . . . . ($418,300)		
Urban & Mixed Open	Reduced Household Consumption $483,377	Total Output . . . . ($671,123) Total Jobs . . . . (8.4) Value Added . . . . ($411,624)	Increase Output: Water Supply & Sewerage $483,377	Total Output . . . . . . $717,913 Total Jobs . . . . 5.6 Value Added $467,143
POTW	Reduced Household Consumption $239,875	Total Output . . . . ($333,044) Total Jobs . . . . (4.2) Value Added . . . . ($204,268)	Increase Output: Water Supply & Sewerage $239,875	Total Output . . . . . . $356,263 Total Jobs . . . . 2.8 Value Added $231,819
Forest	Reduced Output $14,685	Total Output . . . . . ($17,594) Total Jobs. . . . . (0) Value Added. . . . . . ($5,613)	Increase Output: Ag. Services $14,685	Total Output . . . . $21,784 Total Jobs . . . . 1 Value Added $12,648
Total	**Cost $1,934,919**	**Total Output . . ($2,803,052) Total Jobs . . . . (35.9) Value Added . . ($1,412,368)**	**Spending $2,978,754**	**Total Output . . . $4,419,996 Total Jobs . . . . .145.8 Value Added . . . $2,641,582**

Exhibit 4: Economic Impact, Tier 1, District of Columbia

	Tier 1 Costs		Tier 1 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Urban & Mixed Open	Reduce Household Consumption Cost: $334,198	Total Output . . . . ($388,133) Total Jobs . . . . (2.6) Value Added . . . . ($168,685)	Increase Output: Water Supply & Sewerage $334,198	Total Output . . . . . . $496,351 Total Jobs . . . . 3.9 Value Added $322,996
POTW	Reduce Household Consumption Cost: $8,260,558	Total Output . . . ($4,593,706) Total Jobs . . . . (63.8) Value Added . . . ($4,163,522)	Increase Output: Water Supply & Sewerage $8,260,558	Total Output . . . $12,268,606 Total Jobs . . . . 94.9 Value Added $7,983,695
Total	**Cost: $8,594,755**	**Total Output . . ($4,981,839)** **Total Jobs . . . . (66.4)** **Value Added . . ($4,332,207)**	**Spending $8,594,755**	**Total Output . . $12,764,957** **Total Jobs . . . . 98.8** **Value Added . . . $8,306,691**

Exhibit 5: Economic Impact, Tier 1, Maryland

	Tier 1 Costs		Tier 1 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Urban & Mixed Open	Reduce Household Consumption $23,800,346	Total Output . . $32,509,741) Total Jobs . . . . (327.3) Value Added . . ($15,984,621)	Increase Output: Water Supply & Sewerage $23,800,346	Total Output . . . $38,021,437 Total Jobs . . . . 309.8 Value Added 24,838,506
POTW	Reduce Household Consumption $29,478,054	Total Output . . . (40,265,124) Total Jobs . . . . (405.4) Value Added . . ($19,797,843)	Increase Output: Water Supply & Sewerage $29,478,054	Total Output . . . $47,092,340 Total Jobs . . . . 383.7 Value Added . . . $30,765,046
Agriculture – private	Reduce Output $1,352,044	Total Output . . . ($2,245,576) Total Jobs . . . . (36.0) Value Added . . . . ($901,840)	Increase Output: Ag. Services $8,253,812	Total Output . . . $12,941,719 Total Jobs . . . . 464.6 Value Added $7,822,882
Agriculture – public	Reduce Household Consumption $2,208,566	Total Output . . . ($3,016,759) Total Jobs . . . . (30.4) Value Added . . . ($1,483,302)		
Forest	Reduce Output $1,592,527	Total Output . . . ($2,249,093) Total Jobs . . . . (30.4) Value Added . . . . ($866,003)	Increase Output: Ag. Services $1,592,527	Total Output . . . . $2,497,033 Total Jobs . . . . 89.6 Value Added $1,509,381
Total	**Cost $58,431,537**	**Total Output . ($80,286,293)** **Total Jobs . . . . (829.5)** **Value Added . ($39,033,609)**	**Spending $63,124,740**	**Total Output . $100,552,529** **Total Jobs . . . . 1247.7** **Value Added . . $64,935,815**

Exhibit 6: Economic Impact, Tier 1, New York

Source Category	Tier 1 Costs		Tier 1 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Agriculture – private	Reduce Output Cost: $621,761	Total Output .... ($995,942) Total Jobs .... (16.6) Value Added .... ($347,918)	Increase Output: Ag. Services $1,810,767	Total Output .... $2,846,770 Total Jobs .... 85.5 Value Added $1,600,578
Agriculture – public	Reduce Household Consumption Cost: $380,482	Total Output .... ($571,230) Total Jobs .... (7.3) Value Added .... ($340,234)		
Urban & Mixed Open	Reduce Household Consumption Cost: $1,681,854	Total Output ... ($2,525,024) Total Jobs .... (32.3) Value Added ... ($1,503,947)	Increase Output: Water Supply & Sewerage $1,681,854	Total Output .... $2,681,489 Total Jobs .... 23.2 Value Added $1,732,476
Forest	Reduce Output Cost: $3,635,376	Total Output ... ($5,257,087) Total Jobs .... (77.8) Value Added ... ($1,936,036)	Increase Output: Ag. Services $3,635,376	Total Output .... $5,715,303 Total Jobs .... 171.5 Value Added $3,213,392
Total	**Cost $6,319,473**	**Total Output .. ($9,349,283) Total Jobs .... (134.0) Value Added .. ($4,128,135)**	**Spending $7,127,997**	**Total Output .. $11,243,562 Total Jobs .... 280.2 Value Added ... $6,546,446**

Exhibit 7: Economic Impact, Tier 1, Pennsylvania

	Tier 1 Costs		Tier 1 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduce Output Cost: $9,142,941	Total Output . . ($15,786,146) Total Jobs . . . . (312.2) Value Added . . . ($5,860,080)	Increase Output: Ag. Services $22,249,124	Total Output . . . $37,405,582 Total Jobs . . . . 1,091.2 Value Added . . . $22,923,296
Agriculture – public	Reduce Household Consumption Cost: $4,193,979	Total Output . . . ($6,455,721) Total Jobs . . . . (82.1) Value Added . . . ($3,844,700)		
Urban & Mixed Open	Reduce Household Consumption Cost: $8,817,952	Total Output . . ($13,573,324) Total Jobs . . . . (172.6) Value Added . . . ($8,083,583)	Increase Output: Water Supply & Sewerage $8,817,952	Total Output . . . $14,475,079 Total Jobs . . . . 132.7 Value Added $9,341,364
POTW	Reduce Household Consumption Cost: $6,490,146	Total Output . . . ($9,990,172) Total Jobs . . . . (127.0) Value Added . . . ($5,949,639)	Increase Output: Water Supply & Sewerage $6,490,146	Total Output . . . $10,653,878 Total Jobs . . . . 97.6 Value Added $6,875,386
Forest	Reduce Output Cost: $13,880,287	Total Output . . ($20,687,786) Total Jobs . . . . (256.4) Value Added . . . ($9,174,313)	Increase Output: Ag. Services $13,880,287	Total Output . . . $23,335,759 Total Jobs . . . . 680.8 Value Added . . . $14,300,874
Total	**Cost $42,525,305**	**Total Output . ($66,493,149) Total Jobs . . . . (950.3) Value Added . ($32,912,315)**	**Spending $51,437,510**	**Total Output . . $85,870,298 Total Jobs . . . . 2002.3 Value Added . . $53,440,920**

Exhibit 8: Economic Impact, Tier 1, Virginia

	Tier 1 Costs		Tier 1 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Urban & Mixed Open	Reduce Household Consumption Cost: $24,148,648	Total Output . . ($32,577,025) Total Jobs . . . . (327.4) Value Added . . ($15,256,695)	Increase Output: Water Supply & Sewerage $24,148,648	Total Output . . . $37,947,699 Total Jobs . . . . 370.0 Value Added . . . $24,616,027
POTW	Reduce Household Consumption Cost: $8,650,293	Total Output . . ($11,669,424) Total Jobs . . . . (117.3) Value Added . . . ($5,465,104)	Increase Output: Water Supply & Sewerage $8,650,293	Total Output . . . $13,593,254 Total Jobs . . . . 132.5 Value Added $8,817,713
Agriculture – private	Reduce Output Cost: $9,429,871	Total Output . . ($15,185,822) Total Jobs. . . . . (322.5) Value Added . . . ($6,194,244)	Increase Output: Ag. Services $21,580,201	Total Output . . . $33,751,944 Total Jobs . . . . 1,359.8 Value Added . . . $19,705,745
Agriculture – public	Reduce Household Consumption Cost: $3,888,106	Total Output . . . ($5,245,135) Total Jobs . . . . (52.7) Value Added . . . ($2,456,438)		
Forest	Reduce Output Cost: $3,019,242	Total Output . . . ($4,218,641) Total Jobs . . . . (52.4) Value Added . . . ($1,802,385)	Increase Output: Ag. Services $3,019,242	Total Output . . . . $4,722,166 Total Jobs . . . . 190.3 Value Added $2,756,991
Total	**Cost $49,136,160**	**Total Output . ($68,896,047) Total Jobs . . . . (872.3) Value Added . ($31,174,866)**	**Spending $57,398,385**	**Total Output . . $90,015,063 Total Jobs . . . . 2,052.6 Value Added . . $55,896,476**

Exhibit 9: Economic Impact, Tier 1, West Virginia

	Tier 1 Costs		Tier 1 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduce Output Cost: $2,389,320	Total Output . . . ($3,326,288) Total Jobs . . . . (98.3) Value Added . . . . ($807,401)	Increase Output: Ag. Services $5,117,457	Total Output . . . . $7,463,561 Total Jobs . . . . 639.4 Value Added $2,685,912
Agriculture – public	Reduce Household Consumption Cost: $873,004	Total Output . . . ($1,132,731) Total Jobs . . . . (18.2) Value Added . . . . ($639,673)		
Urban & Mixed Open	Reduce Household Consumption Cost: $885,725	Total Output . . . ($1,149,237) Total Jobs . . . . (18.4) Value Added . . . . ($648,984)	Increase Output: Water Supply & Sewerage $885,725	Total Output . . . . $1,264,832 Total Jobs . . . . 16.8 Value Added $802,825
Forest	Reduce Output Cost: $1,328,544	Total Output . . . ($1,605,661) Total Jobs . . . . (21.9) Value Added . . . . ($574,452)	Increase Output: Ag. Services $1,328,544	Total Output . . . . $1,937,617 Total Jobs . . . . 166.0 Value Added $697,290
Total	**Cost $5,476,593**	**Total Output . . ($7,213,917) Total Jobs . . . . (156.8) Value Added . . ($2,670,510)**	**Spending $7,331,726**	**Total Output . . $10,666,010 Total Jobs . . . . 634.5 Value Added . . . $4,186,027**

Exhibit 10: Economic Impact, Tier 2, Delaware

	Tier 2 Costs		Tier 2 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduce Output $1,429,241	Total Output . . . ($2,233,219) Total Jobs . . . . (32.7) Value Added . . . . ($825,394)	Increase Output: Ag. Services $6,334,812	Total Output . . . . $6,894,606 Total Jobs . . . . 70.5 Value Added $997,385
Agriculture – public	Reduce Household Consumption $1,569,783	Total Output . . . ($2,179,494) Total Jobs . . . . (27.3) Value Added . . . ($1,336,764)		
Urban & Mixed Open	Reduce Household Consumption $986,628	Total Output . . . ($1,369,839) Total Jobs . . . . (17.1) Value Added . . . . ($840,172)	Increase Output: Water Supply & Sewerage $986,628	Total Output . . . . $1,464,862 Total Jobs . . . . 11.5 Value Added $952,533
POTW	Reduce Household Consumption $552,811	Total Output . . . . . (767,525) Total Jobs . . . . (9.6) Value Added . . . . ($470,751)	Increase Output: Water Supply & Sewerage $552,811	Total Output . . . . . . $820,767 Total Jobs . . . . 6.4 Value Added $533,708
Forest	Reduce Output $44,020	Total Output . . . . . ($52,738) Total Jobs . . . . (0) Value Added . . . . . ($16,797)	Increase Output: Ag. Services $44,020	Total Output . . . . $65,299 Total Jobs . . . . 2.7 Value Added $37,914
Total	**Cost $4,582,483**	**Total Output . . ($6,602,815) Total Jobs . . . . (86.7) Value Added . . ($3,489,878)**	**Spending $7,918,271**	**Total Output . . . $8,593,142 Total Jobs . . . . 91.1 Value Added . . . $2,521,540**

Exhibit 11: Economic Impact, Tier 2, District of Columbia

	Tier 2 Costs		Tier 2 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Urban & Mixed Open	Reduce Household Consumption Cost: $2,096,140	Total Output . . . ($2,434,430) Total Jobs . . . . (16.2) Value Added . . . . (1,056,505)	Increase Output: Water Supply & Sewerage $2,096,140	Total Output . . . . $3,348,584 Total Jobs . . . . 27.3 Value Added $2,187,572
POTW	Reduce Household Consumption Cost: $14,178,753	Total Output . . ($16,467,022) Total Jobs . . . . (109.5) Value Added . . . ($7,146,436)	Increase Output: Water Supply & Sewerage $14,178,753	Total Output . . . $22,650,558 Total Jobs . . . . 184.6 Value Added . . . $14,797,216
Total	**Cost $16,274,893**	**Total Output . ($18,901,452)** **Total Jobs . . . . (125.7)** **Value Added . . ($8,202,941)**	**Spending $16,274,893**	**Total Output . . $25,999,142** **Total Jobs . . . . 211.9** **Value Added . . $16,984,788**

Exhibit 12: Economic Impact, Tier 2, Maryland

Source Category	Tier 2 Costs		Tier 2 Spending	
	Economic Effect	**Economic Impact**	**Economic Effect**	**Economic Impact**
Urban & Mixed Open	Reduce Household Consumption $47,281,791	Total Output . . ($64,583,885) Total Jobs . . . . (650.2) Value Added . . ($31,755,064)	Increase Output: Water Supply & Sewerage $47,281,791	Total Output . . . $75,533,426 Total Jobs . . . . 615.5 Value Added . . . $49,344,199
POTW	Reduce Household Consumption $36,472,156	Total Output . . ($49,818,618) Total Jobs . . . . (501.5) Value Added . . ($24,495,172)	Increase Output: Water Supply & Sewerage $36,472,156	Total Output . . . $58,265,687 Total Jobs . . . . 474.8 Value Added . . . $38,064,504
Agriculture – private	Reduce Output $1,957,348	Total Output . . . ($3,250,960) Total Jobs . . . . (52.1) Value Added . . . ($1,305,639)	Increase Output: Ag. Services $33,782,377	Total Output . . . $36,976,367 Total Jobs . . . . 316.5 Value Added $5,329,929
Agriculture – public	Reduce Household Consumption $10,184,009	Total Output . . ($13,910,700) Total Jobs . . . . (140.0) Value Added . . . ($6,839,712)		
Industrial	Reduce Output $1,637,472	Total Output . . . ($3,030,934) Total Jobs . . . . (15.0) Value Added . . . . ($844,142)	Increase Output: Water Supply & Sewerage $1,657,472	Total Output . . . . $2,647,537 Total Jobs . . . . 21.6 Value Added $1,729,615
Forest	Reduce Output $1,791,593	Total Output . . . ($2,530,339) Total Jobs . . . . (34.3) Value Added . . . . ($974,253)	Increase Output: Ag. Services $1,791,593	Total Output . . . . $2,809,162 Total Jobs . . . . 100.8 Value Added $1,698,054
Total	**Cost $99,324,369**	**Total Output ($137,125,436)** **Total Jobs . . . . (1393.1)** **Value Added . ($66,213,982)**	**Spending $120,985,389**	**Total Output . $176,232,179** **Total Jobs . . . . 1529.2** **Value Added . . $96,166,301**

Exhibit 13: Economic Impact, Tier 2, New York

	Tier 2 Costs		Tier 2 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduce Output Cost: $3,705,333	Total Output . . . ($5,935,234) Total Jobs . . . . (99.1) Value Added . . . ($2,073,386)	Increase Output: Ag. Services $14,667,478	Total Output . . . $17,572,598 Total Jobs . . . . 239.9 Value Added $4,488,279
Agriculture – public	Reduce Household Consumption Cost: $3,507,886	Total Output . . . ($5,266,507) Total Jobs . . . . (67.3) Value Added . . ($3,136,820)		
Urban & Mixed Open	Reduce Household Consumption Cost: $6,355,003	Total Output . . . ($9,540,979) Total Jobs . . . . (121.9) Value Added . . . ($5,682,768)	Increase Output: Water Supply & Sewerage $6,355,003	Total Output . . . $10,132,193 Total Jobs . . . . 87.6 Value Added $6,546,281
POTW	Reduce Household Consumption Cost: $6,235,642	Total Output . . . ($9,361,778) Total Jobs . . . . (119.7) Value Added . . . ($5,576,033)	Increase Output: Water Supply & Sewerage $6,235,642	Total Output . . . . $9,941,888 Total Jobs . . . . 86.0 Value Added $6,423,327
Forest	Reduce Output Cost: $4,089,798	Total Output . . . ($5,913,903) Total Jobs . . . . (87.5) Value Added . . . ($2,177,659)	Increase Output: Ag. Services $4,089,798	Total Output . . . . $4,899,846 Total Jobs . . . . 66.9 Value Added $1,251,487
Total	**Cost $23,893,663**	**Total Output . ($36,018,401) Total Jobs . . . . (495.5) Value Added . ($18,646,666)**	**Spending $31,347,921**	**Total Output . . $42,546,525 Total Jobs . . . . 480.4 Value Added . . $18,709,374**

Exhibit 14: Economic Impact, Tier 2, Pennsylvania

	Tier 2 Costs		Tier 2 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduce Output Cost: $22,757,591	Total Output . . ($39,293,120) Total Jobs . . . . (777.1) Value Added . . ($14,586,258)	Increase Output: Ag. Services $90,932,696	Total Output . . $119,085,857 Total Jobs . . . . 2,027.0 Value Added . . . $42,580,088
Agriculture – public	Reduce Household Consumption Cost: $21,816,033	Total Output . . ($33,581,971) Total Jobs . . . . (427.0) Value Added . . ($19,999,718)		
Urban & Mixed Open	Reduce Household Consumption Cost: $27,031,192	Total Output . . ($41,608,655) Total Jobs . . . . (529.1) Value Added . . ($24,780,003)	Increase Output: Water Supply & Sewerage $27,031,192	Total Output . . . $42,509,985 Total Jobs . . . . 363.0 Value Added . . . $25,559,464
POTW	Reduce Household Consumption Cost: $31,784,614	Total Output . . ($48,925,517) Total Jobs . . . . (622.1) Value Added . . ($29,137,555)	Increase Output: Water Supply & Sewerage $31,784,614	Total Output . . . $49,985,360 Total Jobs . . . . 426.8 Value Added . . . $30,054,086
Industrial	Reduce Output Cost: $2,043,399	Total Output . . . ($3,303,465) Total Jobs. . . . . (21.3) Value Added . . . ($1,209,462)	Increase Output: Water Supply & Sewerage $2,043,399	Total Output . . . . $3,088,150 Total Jobs . . . . 25.9 Value Added $1,825,244
Forest	Reduce Output Cost: $15,615,323	Total Output . . ($23,273,759) Total Jobs . . . . (288.4) Value Added . . ($10,321,102)	Increase Output: Ag. Services $15,615,323	Total Output . . . $20,449,895 Total Jobs . . . . 348.1 Value Added $7,312,021
Total	**Cost $121,048,153**	**Total Output ($189,986,487) Total Jobs . . . . (2,665) Value Added . (100,034,098)**	**Spending $167,407,224**	**Total Output . $235,119,247 Total Jobs . . . . 3,190.8 Value Added . $109,330,903**

Exhibit 15: Economic Impact, Tier 2, Virginia

Source Category	Tier 2 Costs		Tier 2 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Urban & Mixed Open	Reduce Household Consumption Cost: $59,265,334	Total Output . . ($79,950,162) Total Jobs . . . . (803.5) Value Added . . ($37,442,806)	Increase Output: Water Supply & Sewerage $59,265,334	Total Output . . . $93,130,804 Total Jobs . . . . 908.0 Value Added . . . $60,412,368
POTW	Reduce Household Consumption Cost: $58,092,227	Total Output . . ($78,367,614) Total Jobs . . . . (787.6) Value Added . . ($36,701,658)	Increase Output: Water Supply & Sewerage $58,092,227	Total Output . . . $91,287,359 Total Jobs . . . . 890.1 Value Added . . . $59,216,562
Agriculture – private	Reduce Output Cost: $22,450,623	Total Output . . ($36,154,382) Total Jobs . . . . (767.9) Value Added . . ($14,747,247)	Increase Output: Ag. Services $67,872,330	Total Output . . . $79,583,349 Total Jobs . . . . 1308.4 Value Added . . . $18,959,843
Agriculture – public	Reduce Household Consumption Cost: $14,534,946	Total Output . . ($19,607,944) Total Jobs . . . . (197.1) Value Added . . . ($9,182,926)		
Industrial	Reduce Output Cost: $3,411,858	Total Output . . . ($5,988,217) Total Jobs . . . . (39.4) Value Added . . . ($1,650,747)	Increase Output: Water Supply & Sewerage $3,411,858	Total Output . . . . $5,361,466 Total Jobs . . . . 52.3 Value Added $3,477,892
Forest	Reduce Output Cost: $4,077,351	Total Output . . . ($5,697,085) Total Jobs . . . . (70.8) Value Added . . . ($2,434,040)	Increase Output: Ag. Services $4,077,351	Total Output . . . . $6,377,074 Total Jobs . . . . 256.9 Value Added $3,723,193
Total	**Cost** **$161,597,041**	**Total Output ($225,765,404)** **Total Jobs . . . . (2,666.3)** **Value Added ($102,159,424)**	**Spending** **$192,483,803**	**Total Output . $275,740,052** **Total Jobs . . . . 3,415.7** **Value Added . $145,789,858**

Exhibit 16: Economic Impact, Tier 2, West Virginia

Source Category	Tier 2 Costs		Tier 2 Spending	
	Economic Effect	**Economic Impact**	**Economic Effect**	**Economic Impact**
Agriculture – private	Reduce Output Cost: $5,044,183	Total Output . . . ($7,022,251) Total Jobs . . . . (207.6) Value Added . . . ($1,704,534)	Increase Output: Ag. Services $12,731,013	Total Output . . . $18,567,561 Total Jobs . . . . 1,590.8 Value Added $6,681,908
Agriculture – public	Reduce Household Consumption Cost: $2,459,786	Total Output . . . ($3,191,596) Total Jobs . . . . (51.1) Value Added . . . ($1,802,351)		
Urban & Mixed Open	Reduce Household Consumption Cost: $2,505,462	Total Output . . . ($3,250,861) Total Jobs . . . . (52.1) Value Added . . . ($1,835,814)	Increase Output: Water Supply & Sewerage $2,505,462	Total Output . . . . $3,578,351 Total Jobs . . . . 47.4 Value Added $2,272,026
POTW	Reduce Household Consumption Cost: $1,667,872	Total Output . . . ($2,164,080) Total Jobs . . . . (34.7) Value Added . . . ($1,222,094)	Increase Output: Water Supply & Sewerage $1,667,872	Total Output . . . . $2,382,088 Total Jobs . . . . 31.6 Value Added $1,512,475
Industrial	Reduce Output Cost: $559,099	Total Output . . . . ($758,961) Total Jobs . . . . (5.7) Value Added . . . . ($303,974)	Increase Output: Water Supply & Sewerage $559,099	Total Output . . . . . . $776,128 Total Jobs . . . . 10.3 Value Added $492,792
Forest	Reduce Output Cost: $1,494,612	Total Output . . . ($1,806,368) Total Jobs . . . . (24.7) Value Added . . ($16,950,575)	Increase Output: Ag. Services $1,494,612	Total Output . . . . $2,179,819 Total Jobs . . . . 186.8 Value Added $784,451
Total	**Cost** **$13,731,013**	**Total Output . ($18,194,117)** **Total Jobs . . . . (375.9)** **Value Added . ($23,819,342)**	**Spending** **$18,958,057**	**Total Output . . $27,483,947** **Total Jobs . . . . 1,866.9** **Value Added . . $11,743,652**

Exhibit 17: Economic Impact, Tier 3, Delaware

Source Category	Tier 3 Costs		Tier 3 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Agriculture – private	Reduce Output $2,085,531	Total Output . . . ($3,258,685) Total Jobs . . . . (47.7) Value Added . . . ($1,204,405)	Increase Output: Ag. Services $9,391,828	Total Output . . . $13,931,885 Total Jobs . . . . 571.5 Value Added $8,089,020
Agriculture – public	Reduce Household Consumption $2,338,015	Total Output. . . . ($3,246,111) Total Jobs . . . . (40.6) Value Added . . . ($1,990,959)		
Urban & Mixed Open	Reduce Household Consumption $2,389,458	Total Output. . . . ($3,317,535) Total Jobs . . . . (41.5) Value Added . . . ($2,034,766)	Increase Output: Water Supply & Sewerage $2,389,458	Total Output . . . . $3,547,666 Total Jobs . . . . 27.8 Value Added $2,306,886
Septic	Reduce Household Consumption $181,326	Total Output . . . . ($251,754) Total Jobs . . . . (3.2) Value Added. . . . ($154,410)	Increase Output: Residential Maintenance & Repair $181,326	Total Output . . . . . . $267,969 Total Jobs . . . . 3.3 Value Added $136,512
POTW	Reduce Household Consumption $785,664	Total Output. . . . ($1,090,820) Total Jobs . . . . (13.6) Value Added. . . . ($669,040)	Increase Output: Water Supply & Sewerage $785,664	Total Output . . . . $1,166,488 Total Jobs . . . . 9.2 Value Added $758,514
Forest	Reduce Output $73,355	Total Output . . . . . ($87,884) Total Jobs . . . . (0.4) Value Added. . . . . ($27,990)	Increase Output: Ag. Services $73,355	Total Output . . . . . . $108,815 Total Jobs . . . . 4.5 Value Added $63,179
Total	**Cost $7,853,349**	**Total Output. . ($11,252,789) Total Jobs. . . . . (147) Value Added. . . ($6,081,570)**	**Spending $12,821,631**	**Total Output . . $19,022,823 Total Jobs . . . . 616.3 Value Added . . $11,354,111**

Exhibit 18: Economic Impact, Tier 3, District of Columbia

Source Category	Tier 3 Costs		Tier 3 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Urban & Mixed Open	Reduce Household Consumption Cost: $8,346,901	Total Output . . . ($9,693,984) Total Jobs . . . . (64.5) Value Added . . . ($4,207,041)	Increase Output: Water Supply & Sewerage $8,346,901	Total Output . . . $13,334,500 Total Jobs . . . . 108.3 Value Added $8,651,703
Septic	Reduce Household Consumption Cost: $33,087	Total Output . . . . . ($38,427) Total Jobs . . . . (0) Value Added . . . . . ($16,677)	Increase Output: Residential Maintenance & Repair $33,087	Total Output . . . . $35,955 Total Jobs . . . . 0 Value Added $6,760
POTW	Reduce Household Consumption Cost: $23,228,765	Total Output . . ($26,997,589) Total Jobs . . . . (179.5) Value Added . . ($11,707,862)	Increase Output: Water Supply & Sewerage $23,228,765	Total Output . . . $37,107,952 Total Jobs . . . . 302.4 Value Added . . . $24,241,981
Total	**Cost** **$31,608,753**	**Total Output . ($36,730,000)** **Total Jobs . . . . (244.0)** **Value Added . ($15,931,580)**	**Spending** **$31,608,753**	**Total Output . . $50,478,407** **Total Jobs . . . . 410.7** **Value Added . . $32,900,444**

Exhibit 19: Economic Impact, Tier 3, Maryland

	Tier 3 Costs		Tier 3 Spending	
Source Category	**Economic Effect**	**Economic Impact**	**Economic Effect**	**Economic Impact**
Urban & Mixed Open	Reduce Household Consumption $119,540,360	Total Output . ($163,284,438) Total Jobs . . . . (1,643.9) Value Added . . ($80,284,854)	Increase Output: Water Supply & Sewerage $119,540,360	Total Output . . $190,970,377 Total Jobs . . . . 1,556.1 Value Added . . $124,759,412
POTW	Reduce Household Consumption $83,670,178	Total Output . ($114,288,074) Total Jobs . . . . (1,150.6) Value Added . . ($56,193,974)	Increase Output: Water Supply & Sewerage $83,670,178	Total Output . . $133,666,358 Total Jobs . . . . 1,089.2 Value Added . . . $87,323,155
Agriculture – private	Reduce Output $2,270,873	Total Output . . . ($3,771,694) Total Jobs . . . . (60.4) Value Added . . . ($1,514,774)	Increase Output: Ag. Services $49,607,917	Total Output . . . $54,298,152 Total Jobs . . . . 464.8 Value Added $7,826,764
Agriculture – public	Reduce Household Consumption $15,147,854	Total Output . . ($20,690,993) Total Jobs . . . . (208.3) Value Added . . ($10,173,495)		
Septic	Reduce Household Consumption $3,250,804	Total Output . . . ($4,440,389) Total Jobs . . . . (44.7) Value Added . . . ($2,183,282)	Increase Output: Residential Maintenance & Repair $3,250,804	Total Output . . . . $5,185,404 Total Jobs . . . . 60.7 Value Added $2,567,945
Industrial	Reduce Output $2,676,421	Total Output . . . ($4,882,955) Total Jobs . . . . (26) Value Added . . . ($1,484,169)	Increase Output: Water Supply & Sewerage $2,676,421	Total Output . . . . $4,275,624 Total Jobs . . . . 34.8 Value Added $2,793,164
Forest	Reduce Output $1,990,659	Total Output . . . ($2,811,366) Total Jobs . . . . (38.1) Value Added . . . . ($108,504)	Increase Output: Ag. Services $1,990,659	Total Output . . . . $2,178,868 Total Jobs . . . . 18.7 Value Added $314,071
Total	**Cost $228,547,148**	**Total Output ($314,169,878)** **Total Jobs . . . . (3,172.0)** **Value Added ($152,917,011)**	**Spending $262,280,490**	**Total Output . $390,574,783** **Total Jobs . . . . 3,224.3** **Value Added . $225,584,511**

Exhibit 20: Economic Impact, Tier 3, New York

Source Category	Tier 3 Costs		Tier 3 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Agriculture – private	Reduce Output Cost: $7,959,416	Total Output . . ($12,749,460) Total Jobs . . . . (212.9) Value Added . . . ($4,453,834)	Increase Output: Ag. Services $28,272,341	Total Output . . . $33,872,114 Total Jobs . . . . 462.4 Value Added $8,651,396
Agriculture – public	Reduce Household Consumption Cost: $6,500,136	Total Output . . . ($9,758,872) Total Jobs . . . . (124.7) Value Added . . . . (5,812,548)		
Urban & Mixed Open	Reduce Household Consumption Cost: $21,581,819	Total Output . . ($32,401,508) Total Jobs . . . . (414.1) Value Added . . . (19,298,885)	Increase Output: Water Supply & Sewerage $21,581,819	Total Output . . . $34,409,296 Total Jobs . . . . 297.6 Value Added . . . $22,231,408
Septic	Reduce Household Consumption Cost: $1,131,503	Total Output . . . ($1,698,763) Total Jobs . . . . (21.7) Value Added . . . ($1,011,812)	Increase Output: Residential Maintenance & Repair $1,131,503	Total Output . . . . $1,881,611 Total Jobs . . . . 24.9 Value Added $915,015
POTW	Reduce Household Consumption Cost: $10,184,157	Total Output . . ($15,289,815) Total Jobs . . . . (195.4) Value Added . . . ($9,106,872)	Increase Output: Water Supply & Sewerage $10,184,157	Total Output . . . $16,237,262 Total Jobs . . . . 140.5 Value Added . . . $10,490,688
Forest	Reduce Output Cost: $4,544,220	Total Output . . . ($6,571,359) Total Jobs . . . . (97.2) Value Added . . . ($2,420,045)	Increase Output: Ag. Services $4,544,220	Total Output . . . . $5,444,273 Total Jobs . . . . 74.3 Value Added $1,390,541
Total	**Cost $51,901,250**	**Total Output . ($78,469,777) Total Jobs . . . . (1066) Value Added . ($42,103,997)**	**Spending $65,714,039**	**Total Output . . $91,844,556 Total Jobs . . . . 999.7 Value Added . . $43,679,048**

Exhibit 21: Economic Impact, Tier 3, Pennsylvania

Source Category	Tier 3 Costs: Economic Effect	Tier 3 Costs: Economic Impact	Tier 3 Spending: Economic Effect	Tier 3 Spending: Economic Impact
Agriculture – private	Reduce Output Cost: $36,178,828	Total Output . . ($62,466,143) Total Jobs . . . . (1,235.5) Value Added . . ($23,188,470)	Increase Output: Ag. Services $146,580,789	Total Output . . $191,962,839 Total Jobs . . . . 3,267.4 Value Added . . . $68,637,826
Agriculture – public	Reduce Household Consumption Cost: $35,328,628	Total Output . . ($54,380,757) Total Jobs . . . . (691.5) Value Added . . ($32,286,420)		
Urban & Mixed Open	Reduce Household Consumption Cost: $87,699,911	Total Output . ($134,994,987) Total Jobs . . . . (1,716.5) Value Added . . ($80,396,163)	Increase Output: Water Supply & Sewerage $87,699,911	Total Output . . $136,591,093 Total Jobs . . . . 1,146.6 Value Added . . . $80,731,840
Septic	Reduce Household Consumption Cost: $4,106,021	Total Output . . . ($6,320,328) Total Jobs . . . . (80.4) Value Added . . . ($3,764,067)	Increase Output: Residential Maintenance & Repair $4,106,021	Total Output . . . . $7,378,455 Total Jobs . . . . 93.7 Value Added $3,695,425
POTW	Reduce Household Consumption Cost: $59,952,609	Total Output . . ($42,284,032) Total Jobs . . . . (1,173.4) Value Added . . ($54,959,687)	Increase Output: Water Supply & Sewerage $59,952,609	Total Output . . . $93,375,146 Total Jobs . . . . 783.8 Value Added . . . $55,189,157
Industrial	Reduce Output Cost: $4,136,284	Total Output . . . ($6,641,117) Total Jobs . . . . (57.1) Value Added . . . ($2,651,446)	Increase Output: Water Supply & Sewerage $4,136,284	Total Output . . . . $6,504,834 Total Jobs . . . . 55.5 Value Added $3,911,082
Forest	Reduce Output Cost: $17,350,359	Total Output . . ($25,859,733) Total Jobs . . . . (320.5) Value Added . . ($11,467,893)	Increase Output: Ag. Services $17,350,359	Total Output . . . $22,722,108 Total Jobs . . . . 386.8 Value Added $8,124,469
Total	**Cost $244,752,640**	**Total Output ($332,947,119) Total Jobs . . . . (5,274.9) Value Added ($208,714,146)**	**Spending $319,825,974**	**Total Output . $458,363,925 Total Jobs . . . . 5,731.5 Value Added . $220,122,400**

Exhibit 22: Economic Impact, Tier 3, Virginia

Source Category	Tier 3 Costs		Tier 3 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Urban & Mixed Open	Reduce Household Consumption Cost: $170,502,574	Total Output . . ($230,011,491) Total Jobs . . . . (2,311.6) Value Added . ($107,720,556)	Increase Output: Water Supply & Sewerage $170,502,574	Total Output . . $267,931,348 Total Jobs . . . . 2,612.4 Value Added . . $173,802,520
POTW	Reduce Household Consumption Cost: $101,912,953	Total Output . ($137,482,673) Total Jobs . . . . (1,381.7) Value Added . . ($64,386,827)	Increase Output: Water Supply & Sewerage $101,912,953	Total Output . . $160,148,167 Total Jobs . . . . 1,561.5 Value Added . . $103,885,401
Agriculture – private	Reduce Output Cost: $38,544,411	Total Output . . ($62,071,748) Total Jobs . . . . (1,318.3) Value Added . . ($25,318,849)	Increase Output: Ag. Services $118,252,504	Total Output . . $138,656,363 Total Jobs . . . . 2,279.5 Value Added . . . $33,033,331
Agriculture – public	Reduce Household Consumption Cost: $25,506,590	Total Output . . ($34,408,916) Total Jobs . . . . (345.8) Value Added . . ($16,114,619)		
Industrial	Reduce Output Cost: $7,923,629	Total Output . . ($14,477,606) Total Jobs . . . . (87.4) Value Added . . . ($4,263,483)	Increase Output: Water Supply & Sewerage $7,923,629	Total Output . . . $12,451,358 Total Jobs . . . . 121.4 Value Added $8,076,985
Forest	Reduce Output Cost: $5,135,459	Total Output . . . ($7,175,529) Total Jobs . . . . (89.2) Value Added . . . ($3,065,695)	Increase Output: Ag. Services $5,135,459	Total Output . . . . $6,021,556 Total Jobs . . . . 99 Value Added $1,434,569
Septic	Reduce Household Consumption Cost: $3,944,432	Total Output . . . ($5,321,120) Total Jobs . . . . (53.5) Value Added . . . ($2,492,023)	Increase Output: Residential Maintenance & Repair $3,944,432	Total Output . . . . . 6,569,757 Total Jobs . . . . 83.0 Value Added $3,240,144
Total	**Cost** **$353,470,048**	**Total Output ($490,949,083)** **Total Jobs . . . . (5,587.5)** **Value Added ($223,362,052)**	**Spending** **$407,671,551**	**Total Output . $591,778,549** **Total Jobs . . . . 6,756.8** **Value Added . $323,472,949**

Exhibit 23: Economic Impact, Tier 3, West Virginia

Source Category	Tier 3 Costs		Tier 3 Spending	
	Economic Effect	Economic Impact	Economic Effect	Economic Impact
Agriculture – private	Reduce Output Cost: $9,867,979	Total Output . . ($13,737,690) Total Jobs . . . . (406.2) Value Added . . . ($3,334,594)	Increase Output: Ag. Services $24,175,910	Total Output . . . $35,259,384 Total Jobs . . . . 3020.9 Value Added . . . $12,688,794
Agriculture – public	Reduce Household Consumption Cost: $4,578,538	Total Output . . . ($6,174,249) Total Jobs . . . . (98.9) Value Added . . . ($3,486,707)		
Urban & Mixed Open	Reduce Household Consumption Cost: $7,507,537	Total Output . . . ($7,741,102) Total Jobs . . . . (156.1) Value Added . . . ($5,500,972)	Increase Output: Water Supply & Sewerage $7,507,537	Total Output . . . $10,722,413 Total Jobs . . . . 142.1 Value Added $6,808,054
Septic	Reduce Household Consumption Cost: $379,196	Total Output . . . . ($492,010) Total Jobs . . . . (7.9) Value Added . . . . ($277,847)	Increase Output: Residential Maintenance & Repair $379,196	Total Output . . . . 564,908 Total Jobs . . . . 8.6 Value Added $240,684
POTW	Reduce Household Consumption Cost: $2,424,046	Total Output . . . ($3,145,223) Total Jobs . . . . (50.4) Value Added . . . ($1,776,163)	Increase Output: Water Supply & Sewerage $2,424,046	Total Output . . . . $3,461,584 Total Jobs . . . . 45.9 Value Added $2,197,165
Industrial	Reduce Output Cost: $611,642	Total Output . . . . ($829,570) Total Jobs . . . . (6.2) Value Added . . . . ($332,254)	Increase Output: Water Supply & Sewerage $611,642	Total Output . . . . . . $873,436 Total Jobs . . . . 11.6 Value Added $554,395
Forest	Reduce Output Cost: $1,660,679	Total Output . . . ($2,007,075) Total Jobs . . . . (27.4) Value Added . . . . ($718,065)	Increase Output: Ag. Services $1,660,679	Total Output . . . . $2,422,019 Total Jobs . . . . 207.5 Value Added $871,612
Total	**Cost** **$27,029,617**	Total Output . . ($34,126,919) Total Jobs . . . . (753.1) Value Added . . ($15,426,602)	**Spending** **$36,759,010**	**Total Output . . $53,303,744** **Total Jobs . . . . 3,436.6** **Value Added . . $23,360,704**

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III. Screening-Level Analysis of Potential for Economic and Social Impacts

As described in Part II, one of the factors states may consider in evaluating use attainability is whether controls more stringent than those required by sections 30l(b)(l)(A) and (B) and 306 of the Act would result in substantial and widespread economic and social impact. EPA's Interim Economic Guidelines for Water Quality Standards Workbook (EPA, 1995) provides detailed worksheets and guidance for evaluating whether meeting water quality standards would result in substantial and widespread economic and social impacts.[1] The Chesapeake Bay Program did not attempt to provide conclusions regarding the affordability of controls to meet Bay water quality standards because the Water Quality Steering Committee judged it premature to specify substantial and widespread economic and social impacts thresholds; on a regional, state or large watershed scale, economic impacts can be mitigated by cost-share, loans, new federal or state funding programs; and cost and economic analyses to definitively show impacts that would preclude attainment of these refined uses must be more comprehensive and rigorous than the present screening analyses.
However, in addition to the analysis described in Part II, the Chesapeake Bay Program performed a screening analysis to try to rule out areas that would not experience such impacts. Again, although the tier scenarios likely do not represent the actual control strategies that will be employed by states, and the Chesapeake Bay Program's estimated costs of these scenarios are not precise values, the Chesapeake Bay Program wanted to provide states this information as a starting point for future analyses. The screening analysis described in this part consists of 12 county-level variables or ratios designed to indicate whether either substantial or widespread economic and social impacts would not be likely. For some sectors, the ratios indicate when the estimated control costs are small relative to household incomes and, therefore, substantial impacts are unlikely. For other sectors, the ratios indicates whether the sector is small relative to the local economy and, therefore, widespread impacts are unlikely. Because these screening variables cannot indicate when substantial and widespread impacts *would* occur, this section also provides direction for states regarding the types of information and economic analyses that they would need to conduct and submit to support such a claim.

Part III is organized as follows. Section 1 provides information for states conducting economic analyses as part of UAAs, based on existing EPA guidance in this area. Section 1 also describes, for comparison, the Chesapeake Bay Program's screening analysis. Sections 2 through 8 describe the screening variables, and results by sector. In each of these sections, an example of a more comprehensive analysis for one county is provided as groundtruthing for the screening

[1] Some members of the Chesapeake Bay Program's UAA workgroup raised the issue of other potential social impacts stemming from limits on wastewater treatment plants, as a result of water quality standards eventually imposed by the jurisdictions. Their concern is that nutrient allocation caps on wastewater treatment plants will promote urban sprawl. Most Chesapeake Bay Program partners contend that urban sprawl is occurring now regardless of the nutrient reduction measures that may ultimately be required, that it will not necessarily be affected by POTW caps, and that not all jurisdictions will be imposing such caps. Further, they contend that current policies and growth trends, left unchecked (i.e., the baseline scenario), would show greater environmental impacts than the tier scenarios. However, deliberations on this issue may be valuable on a watershed basis as sprawl is also an interstate issue, and thus are provided in the appendices to this report.

results, as well as to illustrate what an actual analysis of substantial and widespread impacts would consider. Section 9 provides a summary of the results. Appendices to this report provide detailed formulas documenting the screening variables, additional maps, and variable values by county.

1. Application of EPA (1995) Guidance for States Conducting Economic Analyses as Part of UAAs

EPA's (1995) Interim Economic Guidance for Water Quality Standards, Workbook, provides detailed worksheets and guidance for evaluating whether meeting water quality standards would result in substantial and widespread economic and social impacts. The Chesapeake Bay Program used a screening method to try to rule out areas that would not require further consideration because one condition or the other (substantial impacts, or widespread adverse effects) would not likely occur. Because this screening method does not represent the type of economic analysis required as part of a use attainability analysis (UAA), this section provides direction for states regarding the types of information and economic analyses they would need to conduct and submit as part of a UAA.

Specifically, this section describes EPA (1995) guidance, how the screening analyses differ from the analyses in EPA guidance, and the type of economic analyses states should perform (including data to use and level of detail of documentation) for a UAA. The watershed states with tidally influenced Chesapeake Bay waters—Maryland, Virginia, Delaware, and the District of Columbia—are responsible for defining and adopting the designated uses into their state water quality standards. Therefore, economic factors may be of relevance in analyses of use attainability for the Bay.[2]

Section 1.1 provides an overview of EPA (1995) guidance (EPA's 'Interim Economic Guidance for Water Quality Standards, Workbook,' March, 1995). Section 1.2 provides an overview of the screening analysis for substantial and widespread economic and social impacts performed by the Chesapeake Bay Program. Section 1.3 provides direction to assist states in evaluating substantial and widespread impacts for public sector entities, and Section 1.4 addresses private sector entities. Finally, Section 1.5 discusses additional considerations regarding analysis of agricultural and septic sources.

1.1 Overview of EPA (1995) Guidance

EPA (1995) provides guidance for evaluating whether substantial and widespread social and economic impacts will result from water quality standards. As stated in this document, EPA recommends that its guidance, including the various screening levels and measures presented, be implemented as reference points and used as guides by the states and regions. The measures outlined in the guidance are not intended to be applied as absolute decision points. States may use other economically-defensible approaches in lieu of those suggested in the guidance. The

[2] Although the states of New York, Pennsylvania, and West Virginia do not have tidally influenced Bay waters, economic factors there may be considered by those states that do in adopting water quality standards.

economic impacts to be considered are those that result from treatment beyond that required by technology-based regulations. All economic impact analyses of water quality standards should address only the cost of improving the water to meet water quality standards (EPA, 1995).

EPA (1995) guidance applies equally to point and nonpoint sources; the distinction regarding how to analyze different sources relates only to whether a source is public or private, because this indicates how the costs will likely be borne. For example, the applicable substantial impact tests for forestry are impacts on profit and related (e.g., liquidity, solvency) tests for private businesses, and also apply to industrial point sources. Similarly, the substantial impact tests described below for public sector entities apply to publically-owned sewage treatment works (POTWs) as well as municipalities implementing storm water controls.

Substantial Impacts

EPA identifies specific tests of substantial impact, depending on whether the affected discharger is a public or private entity. For the public sector, there is a two part test. The first part of the test, called the Municipal Preliminary Screener (MPS), is a screening level ratio designed to trigger additional tests or screen out the possibility of substantial impacts. Since municipalities will pass all unfunded costs on to households and businesses, this screening is based on how household costs compare to household income. The second part of the test involves calculation of multiple indicators (e.g., bond rating, debt ratio, and tax collection ratio) designed to characterize the financial health of the community. Then, these two test results are evaluated jointly.

For the private sector, the primary test of substantial impacts is how control costs affect profits, based on three years of financial data for the entity. Then, several secondary tests or indicators (e.g., liquidity and solvency ratios) are used to further characterize whether the entity will bear a substantial financial impact. Considerations include whether the private entity will absorb the costs (i.e., out of profits) or will be able to pass all or a portion of costs on to its customers, and whether the entity is an important part of a larger organization that could pay the pollution control costs.

Widespread Impacts

If public or private entities will bear substantial financial impacts, the analysis proceeds to evaluation of whether there will also be an adverse impact on the surrounding community. This step involves estimating socioeconomic changes due to pollution control costs (e.g., loss of employment, changes in property values, and higher taxes), and estimating multiplier effects. That is, the analysis should consider the direct and indirect effects of control costs. Also, expenditures on pollution control costs are not likely to vanish from the community. In reality, these expenditures become business revenues and household incomes that can offset adverse financial impacts experienced by the affected entities.

EPA recommends evaluating socioeconomic impacts by modeling the impact of incremental control costs using a regional economic model. This approach involves developing baseline (i.e., without control costs) and policy (i.e., with control costs) scenarios to identify the incremental impact of meeting water quality standards. Differences in the model outputs across the scenarios provide a forecast of the changes in population, income, sector employment, wage rates, and other economic variables that are attributable to the meeting the standards. Such simulations can be modeled using econometric models, such as those produced by Regional Economic Modeling Inc. or Global Insight (formerly DRI-WEFA), that can also forecast future trends and impacts, or economic impact models such as the Minnesota IMPLAN Group's IMPLAN model (which provides impact estimates for current conditions; it is not a forecasting model).

1.2 Overview of Screening Analysis

As described above, EPA (1995) guidance for evaluating whether controls beyond that required by technology-based regulations (considered the baseline) will result in substantial and widespread social and economic impacts requires **multiple** analyses. These analyses are designed to determine whether costs to meet water quality standards will have a substantial financial impact on those responsible for paying the costs, **and** an adverse impact on the community (i.e., a widespread impact). Conducting a complete analysis of substantial and widespread impacts for all of the affected point (over 330 point sources) and nonpoint sources in the 197 counties and independent cities in the watershed would have been very time consuming and costly. Therefore, to analyze its tiered scenarios of point and nonpoint source controls, the Chesapeake Chesapeake Bay Program developed a screening analysis to identify where county-level costs or economic conditions might have little or no potential to meet EPA's criteria for substantial and widespread social and economic impacts.

The purpose of the screening analysis is to identify areas that can be excluded from further analysis, so that additional expenditures can be focused on evaluating costs and impacts in the remaining areas. This screening-level information may be helpful to states in their own evaluations of meeting Bay water quality standards. However, it should be noted that the analyses are limited even in this respect because the Tier scenarios do not represent the most cost-effective mix of controls for achieving the standards, nor do they represent the likely strategies that will ultimately be implemented by states that would have to form the basis for any economic evaluations.

Nonetheless, the Chesapeake Bay Program constructed a number of screening-level variables at the county level that may provide some indication of whether or not both impact conditions could be met (see **Exhibit 1**). The intent of the analysis is to evaluate conservatively (i.e., err on the side of not excluding a county if potential for substantial and widespread impacts exists) the potential for at least one impact condition, so that areas that do not have potential for either substantial or widespread impacts can be ruled out. If the potential for one impact can be ruled out, data collection and analysis to evaluate the second condition would not be necessary since the area could not meet both conditions. The 12 sector-related screening variables developed by the UAA Workgroup include:

- Agriculture: Average BMP costs/net cash return

- Agriculture: Crop plus portion of hay BMP costs/crop plus hay sales

- Agriculture: Livestock plus portion of hay BMP costs/livestock sales

- Agriculture: Average BMP costs/median household income

- Agriculture: Percent of county earnings from agriculture, agriculture services, food and kindred products, and tobacco sectors/total county earnings

- Forestry: Percent of county earning from forestry and logging/total county earnings

- Urban: Average BMP costs/median household income

- Onsite Treatment Systems: Average BMP costs/median household income

- Onsite Treatment Systems: Percent of households affected in county

- POTWs: Current household sewer rate plus average new household cost/median household income

- POTWs and Urban Combined: Total sewer costs (current plus new) plus average urban BMP cost/median household income

- Industrial: Percent of county earnings from industrial sectors containing affected facilities/total county earnings.

The constructed screening model variables for some sectors indicate when control costs are small relative to household incomes and, therefore, unlikely to meet EPA (1995) guidance conditions for substantial impacts. Variables for other sectors indicate whether they are small relative to the local economy and, therefore, unlikely to meet EPA conditions for widespread impacts. Whether the screening variables for a particular sector address the potential for substantial or widespread impacts depends on the availability of data. Readily available data for constructing the variables include statistics from the Census Bureau's 2000 Census of Population, the Bureau of Economic Analysis' 1999 Regional Economic Information System, the Department of Agriculture's 1997 Census of Agriculture, and the Chesapeake Bay Program's 2010 population and land use projections.

Exhibit 1: Comparison of EPA (1995) Guidance and the Screening Variables Constructed for the Tier Scenarios

	EPA (1995) Tests		Screening Variables for the Tier Scenarios[1]	
Sector	**Substantial**	**Widespread**	**Substantial**	**Widespread**
POTWs (public)	Verify project costs. Define affected community (governmental jurisdiction responsible for paying compliance costs) and calculate annual cost per household.[2] Two-part test consisting of: 1. MPS Screener (annual cost per household/MHI)[3] and, if MPS greater than 1%, 2. Secondary Test (consisting of scores for six indicators: a. bond rating b. net debt/full market value of taxable property c. comparison of unemployment rate to national average d. comparison of MHI to national average e. property tax revenues/full market value of taxable property f. property tax collection rate) with 1& 2 scored jointly.	Define the affected community (geographic area where project costs pass through to the local economy; includes total group of dischargers).[4] Estimated change from precompliance conditions in socioeconomic indicators (MHI, unemployment rate, overall net debt/full market value of taxable property, percent households below poverty line, impact on community development potential, impact on property values). Consider multiplier effect.	Screening-level MPS[2] (e.g., calculated assuming 100% of flow is residential, no funding sources in several states, no real income growth) for each POTW using available data on current cost per household, Chesapeake Bay Program estimates of new control costs per household, and county MHI. (Results reported at county level by population weighting individual facility results for counties served by more than one POTW.) No Secondary Tests.	None
Industrial (private)	Verify project costs. Primary Measure: Impact of Project Costs on Profit. Secondary Measures: Liquidity, Solvency, Leverage.	Impact on affected community (typically, area in which majority of workers live and where most of the businesses that depend on it are located; includes total group of dischargers): comparison of unemployment rate to national average, unemployment rate in community after compliance, MHI, percent of households below poverty line, change in expenditures on social services in affected community, percent of tax revenues paid by affected entity, state unemployment rate after compliance, change in state expenditures on social services.	None	Earnings from discharger category (at 2-digit SIC level) as percent of total earnings.

Exhibit 1: Comparison of EPA (1995) Guidance and the Screening Variables Constructed for the Tier Scenarios

Sector	EPA (1995) Tests		Screening Variables for the Tier Scenarios[1]	
	Substantial	Widespread	Substantial	Widespread
Forestry (private)	Verify project costs. Primary Measure: Impact of Project Costs on Profit. Secondary Measures: Liquidity, Solvency, Leverage.	Impact on affected community (typically, area in which majority of workers live and where most of the businesses that depend on it are located; includes total group of dischargers): comparison of unemployment rate to national average, unemployment rate in community after compliance, MHI, percent of households below poverty line, change in expenditures on social services in affected community, percent of tax revenues paid by affected entity, state unemployment rate after compliance, change in state expenditures on social services.	None	Earnings from forestry and logging as percent of total earnings.
Agriculture (private)	Verify project costs. Primary Measure: Impact of Project Costs on Profit. Secondary Measures: Liquidity, Solvency, Leverage.	Impact on affected community (typically, area in which majority of workers live and where most of the businesses that depend on it are located; includes total group of dischargers): comparison of unemployment rate to national average, unemployment rate in community after compliance, MHI, percent of households below poverty line, change in expenditures on social services in affected community, percent of tax revenues paid by affected entity, state unemployment rate after compliance, change in state expenditures on social services.	Screening level estimates of: 1. Average BMP costs/NCR 2. Crop plus portion of hay BMP costs/crop plus hay sales 3. Livestock plus portion of hay BMP costs/livestock sales 4. Average BMP costs/MHI.	Earnings from agriculture, agriculture services, food and kindred products, and tobacco sectors as percent of total earnings.

Exhibit 1: Comparison of EPA (1995) Guidance and the Screening Variables Constructed for the Tier Scenarios

Sector	EPA (1995) Tests		Screening Variables for the Tier Scenarios[1]	
	Substantial	Widespread	Substantial	Widespread
Urban (public)	Verify project costs. Define affected community (governmental jurisdiction responsible for paying compliance costs) and calculate annual cost per household.[2] Two-part test consisting of: 1. MPS Screener (annual cost per household/MHI)[3] and, if MPS greater than 1%, 2. Secondary Test (consisting of scores for six indicators: a. bond rating b. net debt/full market value of taxable property c. comparison of unemployment rate to national average d. comparison of MHI to national average e. property tax revenues/full market value of taxable property f. property tax collection rate) with 1& 2 scored jointly.	Define the affected community (geographic area where project costs pass through to local economy; includes total group of dischargers).[4] Estimated change from precompliance conditions in socioeconomic indicators (MHI, unemployment rate, overall net debt/full market value of taxable property, percent households below poverty line, impact on community development potential, impact on property values). Consider multiplier effect.	Screening-level estimate of annual cost per household/MHI (e.g., calculated assuming no funding assistance, no real income growth).	None
Onsite (households)	Not applicable (household waste management systems not likely to be funded by municipalities, and households are not private businesses).	Not applicable (household waste management systems not likely to be funded by municipalities, and households are not private businesses).	Screening-level ratio of costs/MHI (e.g., calculated assuming no financial assistance, no real income growth).	Percent of households affected.

Exhibit 1: Comparison of EPA (1995) Guidance and the Screening Variables Constructed for the Tier Scenarios

Sector	EPA (1995) Tests		Screening Variables for the Tier Scenarios[1]	
	Substantial	Widespread	Substantial	Widespread
POTW plus urban (public)	Verify project costs. Define affected community (governmental jurisdiction responsible for paying compliance costs) and calculate annual cost per household.[2] Two-part test consisting of: 1. MPS Screener (annual cost per household/MHI)[3] and, if MPS greater than 1%, 2. Secondary Test (consisting of scores for six indicators: a. bond rating b. net debt/full market value of taxable property c. comparison of unemployment rate to national average d. comparison of MHI to national average e. property tax revenues/full market value of taxable property f. property tax collection rate) with 1& 2 scored jointly.	Define the affected community (geographic area where project costs pass through to local economy; includes total group of dischargers).[4] Estimated change from precompliance conditions in socioeconomic indicators (MHI, unemployment rate, overall net debt/full market value of taxable property, percent households below poverty line, impact on community development potential, impact on property values). Consider multiplier effect.	Screening-level MPS[2] (e.g., calculated assuming 100% of flow is residential, no funding sources for POTW projects in several states, no funding assistance for urban BMPs, and no real income growth).	None

BMP = Best management practices.
MHI = Median household income.
MPS = Municipal Preliminary Screener (defined as incremental household control costs plus existing household sewer rate divided by MHI).
NCR = net cash return.
1. County-level variables. See Appendix B for calculation of screening variables.
2. In the case of a sewerage agency serving several communities, once project costs are allocated to each community, the economic analysis is conducted on a community by community basis. In the case of a community in which only a portion of the community is served, the affected community is defined as those who will pay the compliance costs. In such cases, it may be difficult to obtain data for just part of the community, and data for the entire community may be used instead (EPA, 1995).
3. Defined as total annual sewer rate (current rate plus new costs per household) divided by MHI.
4. While a separate financial analysis should be performed for each facility, the impacts on all facilities should be considered jointly in the analysis of widespread impacts (EPA, 1995).

It is important to recognize that the screening variables do not represent tests of substantial and widespread impacts. This point is also illustrated in Exhibit 1, which shows the corresponding EPA (1995) guidance regarding such tests in comparison to what is measured by the constructed variables. For example, for POTWs, only a screening-level ratio of control costs to median household income (MHI) is constructed as indication of potential for substantial impacts. This variable is *not* the MPS ratio described in EPA (1995) guidance – that is, it does not reflect verified cost estimates for a cost-effective control strategy, the actual portion of costs that will be borne by households as opposed to businesses, or estimated MHIs for the point in time at which the control costs will be incurred by households. Instead, the constructed variable is only a screening-level estimate of the MPS, that incorporates several conservative assumptions (i.e., tending to overstate the ratio) such as that households bear all costs (although in reality, businesses and industries will share some of the control costs) and that there is no real growth in household income between 2001 and the year households incur the costs. And, even if the screening-level MPS estimate accurately reflects the level of impact for a facility, no analysis is performed of whether this impact, considered jointly with the results of secondary tests, would indicate that impacts are substantial.

Similarly, financial data to determine whether substantial impacts would result from controls on industrial dischargers could be difficult to collect (particularly for privately-owned firms). [It is EPA policy, however, that applications based on economic considerations must be accompanied by data that demonstrate the impacts (EPA,1995).] Analysis of these impacts would not be necessary if any substantial impacts are unlikely to adversely affect the community (e.g., because the discharger accounts for a relatively small percent of the local economy). Therefore, the screening variable for industrial dischargers is designed to indicate whether widespread impacts are possible, however, it is *not* a test of widespread impacts. The variable is defined as the earnings in the area attributed to the industrial category of the discharger as a percent of all earnings in the area. Relatively small values for this screening variable would indicate that the discharger is unlikely to adversely affect the community even in the extreme condition that control costs forced it to shut down. However, relatively high values are inconclusive because there may be multiple employers in the same industrial category that are not affected by the tier scenarios (data availability prevent greater disaggregation of industrial categories for this analysis). Also, high values may mean large industries for which control costs can be easily borne (i.e., they would not face substantial impacts and so there would be no adverse impacts on the community even if they do represent a large sector of the economy).

Another area of great uncertainty in the screening variables is funding. Under EPA (1995) guidance, sources of funding (e.g., federal and state grants and cost-share funds) are considered in making a determination of substantial and widespread impacts. For agriculture, the Chesapeake Bay Program compiled all available information on current agricultural cost share amounts for each state. However, due to the large number of programs and sources across states, this information may be incomplete. In addition, these existing funding levels do not incorporate the 2002 Farm Bill. The 2002 Farm Bill increases federal conservation funding by 80% above the level committed by the last (1996) farm bill, including programs for BMPs included in the tier scenarios. The new law also permits a greater percentage of BMP installation costs (90%, up from 75% in the 1996 bill) to be granted to limited-resource farmers under the Environmental Quality Incentives Program. Although the bill includes funding for new conservation programs, it does not include direct funding for a proposed Nutrient Reduction Pilot Program in the Chesapeake Bay watershed. This is the demonstration program for the yield reserve BMP in the tier scenarios. Nevertheless, the program may be funded under an innovative technologies clause (personal communication with T. Simpson, Chair, CBP Nutrient Subcommittee, May 2002). If implemented, this cost-share program could result in annual incentive payments of $20 to $40 per acre. Funding for this program alone would reduce the agricultural costs borne by farmers in Tier 3 by $25 million to $50 million per year. Therefore, costs paid by farmers may be lower than those used in the screening analysis, and impacts may be overstated.

As a result, the screening analysis is very limited. In general, screening analysis is used to identify areas that may not require further research because such analysis would not be worthwhile. In taking this approach, the Chesapeake Bay Program designed the variables to avoid ruling out areas that could have impacts. Therefore, true to this design, the potential for impacts is likely overstated. Nonetheless, as a first step, states can use the results to direct funding or additional analysis to counties or sectors that may not be ruled out at this stage.

1.3 State Analyses of Public Sector Entities

As described above, analysis of whether costs to public sector entities will result in substantial and widespread impacts involves a two-part test of substantial impact, and analysis of whether any substantial impacts will also cause widespread impacts on the community or surrounding area.

1.3.1 Substantial Impacts

For the public sector (e.g., POTWs, municipalities implementing urban runoff controls), relevant costs are costs for control beyond technology-based requirements, that reflect the least-cost means of achieving water quality standards. Therefore, states should estimate the necessary controls for affected sources by first evaluating whether low cost control options would be feasible, and then considering more costly controls, if necessary. As described in EPA (1995) guidance and below, the first step in the analysis of substantial impacts (or in review of facility submissions regarding substantial impacts) is verifying the project costs. Description of the steps follows.

Verify Project Costs

The first step of an economic analysis of a publicly financed project is to evaluate the appropriateness and the cost-effectiveness of the proposed project. Public entities should consider a broad range of discharge management options including pollution prevention, end-of-pipe treatment, and upgrades or additions to existing treatment. Specific types of pollution prevention activities that should be considered are (EPA, 1995):

- public education
- change in raw materials
- substitution of process chemicals
- change in process
- water recycling and reuse
- pretreatment requirements.

Many of these approaches are particularly relevant to industrial indirect discharges to the public wastewater collection system. Whatever the activity, the applicant must demonstrate that the proposed project is the most appropriate means of meeting water quality standards and must document project cost estimates (EPA, 1995). If at least one of the treatment alternatives that meets water quality standards will not have a substantial financial impact then, regardless of whether the discharger prefers to implement a different treatment alternative, the applicant is not able to demonstrate substantial financial impacts and should not proceed with the analysis presented in the rest of this guidance. EPA (1995) provides a worksheet to summarize general information regarding the proposed pollution control project (see Worksheet A).

Documentation of project costs should include assumptions about excess capacity, population growth, and consideration of alternative technologies where appropriate. The most accurate estimate of project costs may be available from the discharger's design engineers. If site-specific engineering cost estimates are not available, preliminary project cost estimates can be derived from a comparable project in the state or from the judgement of experienced water pollution control engineers. Capital, O&M, and other project costs can be summarized using Worksheet B in EPA (1995). For comparative purposes, cost estimates (e.g. capital, O&M, other project costs) for each alternative considered should be presented in the same units (typically annualized costs expressed in dollars per year) and for the same year.

Calculate Annualized Cost per Household

Since capital costs will be paid over several years, annualized costs are used to evaluate the economic burden to the community. The capital portion of project costs is financed by issuing a municipal debt instrument such as a general obligation bond or a revenue bond. Local governments may also finance capital costs using bank loans or state infrastructure loans (e.g., State Revolving Fund loans). State and federal grant funding may also be available for technology upgrades or other treatment options.

EPA (1995) also provides a worksheet for calculating the total annualized cost of the project (see Worksheet B). Capital costs are summed and the portion of costs to be paid for with grant monies are deducted, as these costs will not need to be financed. Annualized capital costs are calculated based on the anticipated interest rate. O&M costs are summed to obtain an annual estimate for a typical year, and the total is added to the annualized capital cost for a total annual project cost. O&M costs should include the costs of monitoring, inspection, permitting fees, waste disposal charges, repair, administration, replacement, and any other recurring costs. All recurring costs should be stated in terms of dollars per year.

Calculate Total Annualized Pollution Control Cost per Household

To assess the burden that pollution control costs are expected to have on households, an average annualized pollution control cost per household should be calculated for all households in the community that would bear project costs. To evaluate substantial impacts, therefore, states should determine which households will actually pay for pollution control, as well as what proportion of the costs will be borne by households. These apportioned project costs are then added to existing pollution control costs paid by households.

Thus, the first step in calculating the cost per household is to identify the affected community. The "community" is the governmental jurisdiction responsible for paying compliance costs. In practice, pollution control projects may serve several communities, or just portions of a community. In the case of a POTW serving several communities, the economic analysis is conducted on a community by community basis once project costs are allocated to each community served. In the case of a POTW serving only a portion of a community, the affected community is defined as those who will pay the compliance costs. In such cases, it may be difficult to obtain socioeconomic data for just part of the community, and data for the entire community may be used instead.

If project costs are not distributed simply according to wastewater flow or tax revenues, then consideration should be given to separately analyzing the impacts on users who pay a disproportionate share of the costs. This situation can arise, for example, where industrial dischargers to a sewer system are assessed pollutant surcharges to pay for their share of the cost of advanced treatment necessitated by the presence of their pollutants. Remaining costs would then be split among households according to wastewater flow or tax revenues, whichever is appropriate. The total amount of the pollution control project to be recouped by surcharges should, therefore, be removed from the total project cost before costs are allocated according to wastewater flow or tax revenues.

The total annual cost of pollution control per household is based on current costs of pollution control and the projected annual costs of the proposed pollution control project. The current sewer rate per household will likely be information known by applicants submitting requests on behalf of POTWs. However, if the applicant (or reviewer) does not have the necessary information, the local government's public works department, tax and utilities division, or billing office should have sewer and water rates available. This information can usually be obtained from the municipality's website (if available), or by contacting each department by telephone. Rates may be given in dollars per volume of water used per household. In this case, the rate should be multiplied by the average household water consumption rate to obtain an average household sewer rate. To estimate the average amount of water used per household, contact the POTW for information on total daily residential inflow and the number of households served by the facility.

EPA (1995) provides worksheets for calculating the cost per household. If the portion of proposed project costs that households are expected to pay is known or is expected to remain unchanged, then states should use Worksheet C; if the portion paid by households is based on flow, then states should use Worksheet C: Option A.

Calculate and Evaluate the Municipal Preliminary Screener Value

Whether or not the community is expected to incur "substantial" economic impacts due to the pollution control project is determined by jointly considering the results of two tests. The first test is a "screener" to establish whether the community can clearly pay for the project without incurring any substantial impacts. The MPS estimates the total annual pollution control costs per household (existing costs plus those attributable to the proposed project) as a percentage of MHI. The screener is calculated as follows:

$$\text{Municipal Preliminary Screener} = \frac{\text{Average Annual Control Cost per Household}}{\text{Median Household Income}}$$

The primary source of MHI is the U.S. Census Bureau (see http://www.census.gov). The Decennial Census of Population and Housing (e.g., the 2000 Census) provides the most comprehensive coverage with income data at almost any geographic level including for the Nation, states, counties, and census block group and tract. In years not covered by the Decennial Census, the Census Bureau Small Area Income and Poverty Estimates program provides model-based estimates of MHI at the county level. State data centers and some communities may also provide MHI data. MHI will usually need to be inflated to the current year. This is done using the CPI index, published by the BLS (see http://www.bls.gov).

Depending on the results of the screener, the community is expected to incur little, mid-range, or large economic impacts due to the proposed project [see Worksheet D in EPA (1995)]. If the MPS value is less than 1.0, there is little potential for substantial impacts and the analysis can conclude with a determination of no substantial impact. The discharger is assumed to be able to pay for pollution control without incurring any substantial economic impacts, and is required to meet existing water quality standards. Therefore, states do not need to proceed to the Secondary Test or evaluate widespread impacts. However, states may want to proceed to the Secondary Test if the MPS result is less than1.0, but still fairly close to 1.0, in a jurisdiction in economic distress.

Communities are expected to incur mid-range impacts when the ratio of total annual compliance costs to MHI is between 1.0% and 2.0%. If the average annual cost per household exceeds 2.0%, then the project may place an unreasonable financial burden on many of the households within the community. In either case, applicants move on to the Secondary Test to demonstrate substantial impacts.

Evaluate Secondary Test

The Secondary Test is designed to build upon the characterization of financial burden identified in the MPS. The Secondary Test indicates the community's ability to obtain financing and describes the socioeconomic health of the community. Indicators describe precompliance debt, socioeconomic, and financial management conditions in the community. Using these indicators and the scoring system described below, the applicant estimates the impact of the cost of pollution controls. Specifically, applicants are required to present the following six indicators for the community:

- Debt Indicators
  - Bond Rating - a measure of a jurisdiction's ability to repay its debt
  - Overall Net Debt as a Percent of Full Market Value of Taxable Property - a measure of debt burden on residents within the jurisdiction
- Socioeconomic Indicators
  - Unemployment Rate - a measure of the economic health of the jurisdiction
  - MHI - a measure of the income of the jurisdiction

- Financial Management Indicators
    - Property Tax Revenue as a Percent of Full Market Value of Taxable Property - a measure of the capacity to support debt based on the wealth of the jurisdiction
    - Property Tax Collection Rate - a measure of the strength of the local government administration, and of the jurisdiction's acceptance of property tax rates.

A more detailed description of the six indicators, as well as alternative indicators for states with property tax limitations, are presented below. **Exhibit 2** summarizes the indicators, what is considered to be strong, mid-range, or weak rating, and the associated scoring for the test.

Exhibit 2: Secondary Indicators

	Secondary Indicators		
Indicator	**Weak (score of 1 point)**	**Mid-Range (score of 2 points)**	**Strong (score of 3 points)**
Bond Rating	Below BBB (Standard and Poor's) Below Baa (Moody's)	BBB (Standard and Poor's) Baa (Moody's)	Above BBB (Standard and Poor's) Above Baa (Moody's)
Overall Net Debt as Percent of Full Market Value of Taxable Property	Above 5%	2% - 5%	Below 2%
Unemployment	More than 1% above National average	National average	More than 1% below National average
MHI	More than 10% below State median	State median	More than 10% above State median
Property Tax Revenues as a Percent of Full Market Value of Taxable Property	Above 4%	2% - 4%	Below 2%
Property Tax Collection	Below 94%	94% - 98%	Above 98%

Source: See U.S. EPA (1995), Table 2-1.

The debt, socioeconomic, and financial management indicators for the secondary test are described in detail in EPA (1995).

Calculating the Secondary Score

EPA (1995) provides worksheets for calculating the secondary score. Worksheet E can be used to record each indicator. A Secondary Score is calculated for the community by weighting each indicator equally and assigning a value of 1 to each indicator judged to be weak, a 2 to each indicator judged to be midrange, and a 3 to each strong indicator. A cumulative assessment score is arrived at by summing the individual scores and dividing by the number of factors used. Worksheet F can guide states through this calculation.

The cumulative assessment score is evaluated as follows:

- less than 1.5 = weak
- between 1.5 and 2.5 = mid-range
- greater than 2.5 = strong.

If states are not able to develop one or more of the six indicators, they should provide an explanation as to why the indicator is not appropriate or not available. Since the point of the analysis is to measure the overall burden to the community, the debt and socioeconomic indicators are assumed to be better measures of burden than the financial management indicators. Consequently, if one of the debt or socioeconomic indicators is not available, the state or discharger should average the two financial management indicators and use this average value as a single indicator with the remaining indicators. This averaging is necessary so that undue weight is not given to the financial management indicators.

Evaluate the MPS and Secondary Score

States should then evaluate results of the MPS and Secondary Test to determine whether the jurisdiction is expected to incur substantial impacts due to the proposed pollution control project. States should use the Substantial Impacts Matrix shown in **Exhibit 3** for this evaluation.

Exhibit 3: Substantial Impacts Matrix

	Municipal Preliminary Screener		
Secondary Score	**Less than 1.0%**	**Between 1.0% and 2.0%**	**Greater than 2.0%**
Less than 1.5	?	X	X
Between 1.5 and 2.5	✓	?	X
Greater than 2.5	✓	✓	?

Source: See EPA (1995), Table 2-2.

An "X" in the matrix indicates that the impact is likely to be substantial. The closer the community is to the upper right hand corner of the matrix, the greater the impact. Similarly, the "✓" indicates that the impact is not likely to be substantial. The closer to the lower left hand corner of the matrix, the smaller the impact. Finally, the "?" symbol in Exhibit 3 indicates that the impact is unclear.

For communities that fall into the "?"category, if the results of both the Secondary Test and the MPS are borderline, then the community should move into the category closest to it. For example, a community with an MPS of 1.8% and a Secondary Score of 1.6 would fall into the center box. Because of the proximity of the MPS to the 2.0% threshold, and the proximity of the Secondary Score to the 1.5 threshold, the jurisdiction should be considered to fall into one of the adjacent "X" categories. If the results are not borderline, then other factors such as the impact on low or fixed income households or the presence of a failing local industry should be considered. [Sources of information may include the Decennial Census of Population and Housing (http://www.census.gov), state Data Centers (http://www.census.gov/sdc/www), or municipal financial officers (see local government website or listings for contact numbers]. The applicant should provide any additional information it feels is relevant; this information may be critical where the matrix results are not conclusive.

EPA will interpret a "✓" rating to mean that the jurisdiction is not expected to incur substantial impacts as a result of the pollution control project. Communities falling into this category will not be able to justify water quality standards providing for less protection than the fishable/swimmable goals of the Act. (If the applicant disagrees with the results of the Secondary Test, they may present additional information to the Regional EPA Administrator documenting the unique circumstances of the community.) Since the impacts are not substantial, there is no need to demonstrate widespread impacts.

EPA will interpret an "X" rating to mean that the community will incur substantial impacts. Before a water quality standard can be modified or changed, however, communities falling into this category must demonstrate that impacts are also widespread. For those communities rated "?," EPA's interpretation will rely on the additional information presented by the state or applicant. In this case, there is no "correct" set of information; it will be up to the applicant to collect whatever information it feels is relevant in describing the unique circumstances affecting the jurisdiction. For example, the matrix may suggest that the community's financial condition is strong. At the same time, however, a local industry may be failing. In such a case, it is important to determine the importance of that industry to the local economy (as measured by its contribution to area employment, payroll, and tax revenues), and whether the industry itself would be affected by the project. Communities falling into either the "X" or "?" category should proceed to determine whether the impacts are also expected to be widespread.

Environmental Justice Considerations

It is important to note that the MPS is more likely to indicate potential for substantial economic impacts in communities that have lower MHIs for two reasons. First, lower income households already pay a larger portion of household income for utility services such as sewer service; any subsequent increase in these costs is more likely to push total costs over the threshold of 1.0% of household income. Second, any incremental cost (e.g., $100) constitutes a larger share of their household income compared to higher income households, so the MPS is more sensitive to increases in sewer costs in communities with lower median incomes.

The implication is that a conclusion of substantial economic impacts is more likely for communities with lower MHIs. It is important, however, that this conclusion not be the deciding factor for whether to implement measures to improve water quality for two reasons: it is potentially subverts the principle of environmental justice and it neglects funding resources outside the community.

The principle of environmental justice is embodied in Executive Order 12898. This executive order ensures that regulations do not impose disproportionately high and adverse human health or environmental effects on minority and low-income populations. If low-income communities were exempted from implementing wastewater treatment technologies to improve water quality simply because their low incomes result in high MPS values and low Secondary Test scores, then these communities would have poorer water quality precisely because they are low-income communities. This is contrary to the spirit of the Executive Order.

On the other hand, adhering to the principle of environmental justice may seem to impose disproportionately higher costs on minority and low-income households to protect health and the environment. Thus, there may be tension between protecting health and environment and avoiding high economic impacts. However, the resolution may be to look for additional revenue sources to offset costs, such as resources at the federal and state level to assist funding for wastewater treatment plant upgrades. For example, some federal and state sources prioritize grant funding for communities that could not otherwise afford wastewater treatment plant upgrades. State revolving funds may also make loans with lower interest rates more available for lower-income communities, which would result in reduced economic burdens due to lower annualized capital expenditures. Thus, the initial response to an MPS value greater than 1.0 in a lower-income community might be to reassess the cost analysis to determine whether all feasible forms of financial assistance have been included.

However, even if applicants have not identified funding sources, states have the responsibility to provide environmental protection to low-income communities and assure that applicants do not use low-income communities as an excuse not to provide pollution control.

1.3.2 Widespread Impacts

The financial impacts of undertaking pollution controls could potentially cause far-reaching and serious socioeconomic impacts. Conversely, adverse financial impacts experienced by the affected entities may be offset by the expenditures on pollution controls to attain water quality standards, since these expenditures do not vanish from the community but become business revenues and household incomes. Therefore, if a discharger or group of dischargers are expected to incur substantial impacts, to demonstrate that impacts will also be widespread, the applicant must examine the estimated <u>change</u> in socioeconomic conditions that occur as a result of compliance (EPA, 1995).

At a minimum, the analysis must (EPA, 1995):

- define the affected community (the geographic area where project costs pass through to the local economy)
- consider the baseline economic health of the community
- evaluate how the proposed project will affect the socioeconomic well-being of the community.

These steps are described below. In all cases, socioeconomic impacts should not be evaluated incrementally, rather, their cumulative effect on the community should be assessed (EPA, 1995).

Define Relevant Geographic Area

For municipal control projects, the affected community is most often the immediate municipality. There are, however, exceptions where the affected community includes individuals and areas outside the immediate community. For example, if business activity in the region is concentrated in a nearby community and not in the immediate community, then the nearby community may also be affected by loss of income in the immediate community and should be included in the analysis. If business activity of the region is concentrated in the immediate community, then outlying communities dependent upon the immediate municipality for employment, goods, and services should also be included in the analysis.

As discussed previously, in some instances, several entities potentially may suffer substantial impacts. For example, this situation can arise where several facilities are discharging to a stream segment that is being considered for a change in designated use. Although a separate financial analysis should be performed for each facility, the impacts on all the facilities should be considered jointly in the analysis of widespread impacts.

Defining the relevant area or community is based on the judgement of the discharger and state, subject to EPA review.

Evaluate Baseline Economic Health of the Community

In demonstrating that impacts will be substantial, the state will have shown that compliance with water quality standards would be burdensome to the community. To demonstrate that impacts will also be widespread, the state must evaluate the change in socioeconomic conditions that will occur as a result of compliance. Specifically, EPA (1995) recommends evaluating changes in the following indicators:

- MHI
- community unemployment rate
- overall net debt as a percent of full market value of taxable property
- property values
- percent of households below poverty line
- community development potential.

The first step in estimating the change in these indicators is to identify their precompliance values. The applicant developed precompliance estimates of the first three indicators for the jurisdiction paying the immediate project costs as part of the Secondary Test. If the relevant geographic area for evaluation of widespread impacts defined above differs from the area used to evaluate the Secondary Test, the applicant will need to estimate precompliance values for this larger area (see the discussion of the Secondary Test for sources of data). Property values are a component of the third indicator (i.e., full market value of taxable property). The percent of households below the poverty line can be found in the Decennial Census of Population and Housing or, in years between Decennial Censuses, through the Census Bureau Small Area Income and Poverty Estimates program (for counties). Communities may be faced with impaired development opportunities if pretreatment requirements or significantly higher user fees are imposed by the POTW. Therefore, baseline development opportunities can be examined by comparing current fees to costs in neighboring communities.

Evaluation of baseline socioeconomic conditions is important because the extent to which estimated changes can be interpreted as significant depends on the health of the community before compliance. For example, if a community is in a weak condition before compliance but the evaluation of widespread impacts suggests that all of the indicators listed above will remain virtually unchanged, then widespread impacts have not been demonstrated. Alternatively, if the community is very healthy, the estimated change in the indicators listed above would have to be very large in order for widespread impacts to occur.

Estimate Changes in Economic Health of the Community

The best way to estimate changes in the socioeconomic conditions in a community is through use of a macroeconomic or regional economic model because such models capture the complex industrial and market relationships that are difficult to evaluate otherwise. For example, costs to one sector are revenues to another, and this distributional effect is important to show because it is not realistic to assume that the costs vanish from the economy (see **Exhibit 4**). Indeed, for large economies, this may be the only way such changes can be adequately modeled. Two commonly used models include those supplied by REMI (Regional Economic Models, Incorporated) and the Minnesota IMPLAN Group.

If it is not possible to use a regional model, EPA (1995) provides a worksheet to describe estimated changes (both positive and negative) qualitatively. (see Worksheet N). Depending on the size and type of impacts on industrial and commercial discharges, these estimated changes may be relatively large or small. In addition to changes in income, unemployment, and debt, affected communities may be faced with impaired development opportunities if pretreatment requirements or significantly higher user fees are imposed by the POTW. The municipality should therefore assess the potential for the loss of future jobs and personal income to the community if businesses would choose not to locate in the affected community. The potential for impaired development opportunities can be judged, in part, by comparing post-compliance costs to costs in neighboring communities. The cost of pollution control may also have an adverse effect on property values. Where property taxes are used to finance the project, property values may fall in response to higher taxes. Similarly, if the project will be financed through user fees, demand for property in the community may fall, thus decreasing the value of property in the community.

Exhibit 4: Impacts from Expenditures on Pollution Controls by Public-Sector Entities

Source Category	Cost Impacts	Revenue and Wage Impacts
POTWs	▪ Municipal expenditures for capital, operating, and maintenance ▪ Increase in household sewer rates	▪ Revenues: incremental sewer fees accrue to municipality; incremental sales in sectors providing control equipment/materials such as construction, chemicals, and energy ▪ Wages: incremental wages in public sector and sectors providing control equipment/materials
Urban Storm Water	▪ Municipal expenditures for capital, operating, and maintenance ▪ Households: incremental property taxes or fees	▪ Revenues: incremental sewer fees accrue to municipality, incremental sales in sectors providing control equipment/materials (e.g., construction and landscape) ▪ Wages: incremental wages in public sector and sectors providing control equipment/materials

Note: Cost impacts need to be matched with revenues to another sector, although these revenues may not always accrue within the project area.

Secondary Impacts

In addition, there may be secondary impacts (not captured by the primary and secondary tests) to the community. Secondary impacts might include depressed economic activity in a community resulting from loss of purchasing power by persons losing their jobs due to increased user fees. The effects of increased unemployment, decreased personal income, and reductions in local expenditures by the entity or group of entities (public and private) will be compounded as money moves through the local economy. Some portion of the lost income would have been spent in the local economy for the purchase of other goods and services and thus for the salaries of other local employees. These local employees, in turn, would have spent some portion of their income in the local economy. This multiplier effect means that each dollar lost to an employee results in the loss of more than one dollar to the local economy. However, as discussed above, the expenditures for pollution controls also become increased household and business incomes with similar multiplier effects (i.e., a dollar spent on pollution control results in spending of more than one dollar in the local economy).

As discussed above, these multiplier effects are captured with the use of a regional economic model of the area. The U.S. Department of Commerce, Bureau of Economic Analysis (BEA) has also developed several multipliers to estimate the effect of changes in economic activity on output (sales), earnings, and employment. These multipliers are available by industry sector for 39 or 531 different industry classifications, depending on the level of detail required. EPA (1995) provides additional information on references for these multipliers. Note, however, that if multiplier analysis is used, care should be taken to model both the impacts of costs due to pollution controls **as well as** increased revenues and wages from these expenditures to evaluate widespread impacts.

Benefits of Clean Water

Finally, although benefit-cost analysis is not required to demonstrate substantial and widespread effects under the Federal Water Quality Standards regulation, there may be economic benefits that accrue to the affected community from cleaner water. For example, whereas the section above discussed the possibility that property values may fall in response to higher taxes, improved water quality may cause property values to rise. In rural communities where the primary source of employment is agriculture, the reduction of fertilizer and pesticide runoff from farms would reduce the cost of treating irrigation. Another example might be an industrial facility discharging its wastewater into a stream that otherwise could be used for recreational cold-water fishing. Treatment or elimination of industrial wastewater to a potential cold-water fishery would provide a benefit to recreational anglers by increasing the variety of fish in the stream. The economic benefit in these examples is the dollar value associated with the increase in beneficial use or potential use of the waterbody. The types of economic benefits that might be realized will depend on both the characteristics of the polluting entity and the affected community, and should factor into the evaluation of widespread impacts.

Since the assessment of benefits requires site-specific information, it will be up to states to determine the extent to which benefits can be considered in the economic impact analysis. This determination should be coordinated with the EPA Regional Office. A detailed description of the types of benefits that might be relevant is provided in U.S. EPA (2000).

1.3.3 Summary: Determining Whether Impacts are Substantial and Widespread

Using EPA (1995) guidance, states must demonstrate that the pollution control measures needed to meet water quality standards are not affordable. In addition, states will have to show that there will be widespread adverse impacts to the community or surrounding area if it is required to meet standards. EPA (1995) provides a summary checklist of the steps required in this process, and the information that will be required from states (see Table 4-1 in EPA, 1995, also updated below in **Exhibit 5** for public sector entities). Whether or not the applicant has successfully demonstrated that substantial and widespread economic and social impacts would occur, however, will depend upon the EPA Regional Administrator's review of the application. As discussed above, environmental justice considerations are important (states have the responsibility to provide environmental protection to low-income communities and assure that applicants do not use low-income communities as an excuse not to provide pollution control).

Exhibit 5: Demonstration of Substantial and Widespread Economic and Social Impacts Checklist: Public-Sector Entities

Steps	Information That Will Be Required from Applicant
☐ 1. Demonstrate that designated use is a potential use and not an existing use.	Data from State Water Quality Assessment Documents and water quality standards regulations.
☐ 2. Demonstrate that entity will incur substantial economic impacts:	
☐ a. Identify all reasonable pollution reduction options	Information on end-of-pipe treatment, possible treatment upgrades, additions to existing treatment, and pollution prevention activities including the following:

Exhibit 5: Demonstration of Substantial and Widespread Economic and Social Impacts Checklist: Public-Sector Entities

Steps	Information That Will Be Required from Applicant
	• change in raw materials • substitution of process chemicals • change in process • water recycling, reuse and efficiency • pretreatment requirements • public education.
☐ b. Evaluate costs of all reasonable pollution reduction options	Assumptions about water demand, treatment capacity, expansion plans, population growth, and effectiveness of control in reducing pollution for each option. Estimate of project costs from design engineers, costs of comparable projects in the state, or judgment of experienced water pollution control engineers.
☐ c. Identify lowest cost pollution reduction option that allows entity to meet water quality standards.	Information on treatment efficiencies for alternative pollution reduction techniques. Cost estimates for all alternatives.
☐ d. determine method of financing	Information on user fee financing mechanisms such as Revenue Bonds. Information on tax-based financing mechanisms such as General Obligation Bonds.
☐ e. annualize pollution reduction project costs	Information on appropriate interest rates and period of financing.
☐ f. allocate project costs	Information on user groups, wastewater flow by user group, and surcharges on industrial users.
☐ g. apply Municipal Preliminary Screener test	Information on average total annual pollution control cost per household and MHI.
☐ h. Depending on the results of the Municipal Preliminary Screener test, apply Secondary Test.	Information on results of Municipal Preliminary Screener test, overall net debt as a percent of full market value of taxable property, MHI, bond rating, community unemployment rate, property tax collection rate, and property tax revenues as a percent of full market value of taxable property.
☐ 3. Determine whether impacts are widespread:	
☐ a. Evaluate **change** in socioeconomic conditions that occur as a result of compliance.	Information on **changes** in MHI, community unemployment rate, overall net debt as a percent of full market value of taxable property, percent of households below the poverty line, impact on community development potential, and impact on community property values resulting from compliance.
☐ 4. Evaluate economic benefits of cleaner water.	Information on potential benefits of cleaner water including enhanced recreational opportunities, reduced treatment costs for downstream users and increased property values.
☐ 5. Public comment and debate period.	Be prepared to supply backup information on the application to modify or change a designated use to the public.

Exhibit 5: Demonstration of Substantial and Widespread Economic and Social Impacts Checklist: Public-Sector Entities

	Steps	Information That Will Be Required from Applicant
☐	6. If substantial and widespread economic and social impacts are demonstrated, determine which pollution reduction option should be implemented.	Information on the cost and efficiency of affordable pollution reduction alternatives.
☐	7. Grant variance (i.e., when impacts driven by few pollutants) or redesignate uses.	Information on pollutants reductions and associated costs driving finding of substantial and widespread impacts.
☐	8. Criteria will be adopted to protect new uses, or a variance to the water quality standard for certain pollutants will be granted on a temporary basis.	Information on the "affordable" pollution reduction technique.
☐	9. Effluent limits and permits will be modified.	Information on the "affordable" pollution reduction technique.
☐	10. Re-evaluate water quality standards in three years.	Re-evaluation of costs, including new information or technology that allows attainment of the full designated uses without causing a substantial and widespread economic and social impact.

Source: See EPA (1995), Table 4-1.

The state or regulating entity should keep in mind that substantial and widespread impacts driven by one or a few pollutants should not be the basis for downgrading a waterbody for which the current use includes criteria for a wide spectrum of pollutants (e.g., fishable/swimmable use, with acute and chronic aquatic life and human health protection). Instead of downgrading to a use with only criteria for a few pollutants (e.g., agricultural and industrial use with acute aquatic life protection for a handful of pollutants), a variance for the pollutants driving the impacts is appropriate. In this manner, the adverse economic impacts are avoided while maintaining the maximum level of environmental protection.

It is then up to the state to revise the standards in the water body to reflect the uses that would be achieved if the discharger adopts the next most protective pollution control technique. The state will also have to revise its water quality criteria to protect the newly attainable uses. The discharger's NPDES permit will also be revised to reflect the new limits associated with revised criteria. Finally, federal regulations require that water quality standards be reviewed every three years to determine if there is any new information or technology that allows attainment of the full designated use (in the case of a variance) without causing substantial and widespread social and economic impacts. If waters have been downgraded, the state should also determine if economic conditions in the community have changed such that the use can now be upgraded without causing substantial and widespread social and economic impacts.

1.4 STATE ANALYSES OF PRIVATE SECTOR ENTITIES

For facilities owned by the private sector -- such as the industrial facilities, agricultural, and forestry sources in the tier scenarios -- measuring substantial impacts requires estimating the financial impacts on the entities that will pay for the pollution controls. If the analysis shows that the entity will not incur any substantial impacts due to the cost of pollution control (e.g., there will be no significant changes in the factory's level of operations nor profit), the analysis is complete. However, if the analysis shows that there will be substantial impacts on the entity, then the resulting impacts on the surrounding community must be considered (e.g., the impact of lost employment on the community's employment base, or the impact on the overall economy of the community). Impacts to the surrounding community are referred to as widespread impacts.

1.4.1 Substantial Impacts

The sections below describe the steps involved in evaluating whether impacts on private-sector entities will be substantial. Also discussed is how to adapt each of the steps to a range of data sources. The approach involves two steps, and can be used for a variety of private-sector entities, including commercial, industrial, residential and recreational land uses, and for point and nonpoint sources of pollution:

- Verify project costs and calculate the annual cost of the pollution control project
- Conduct financial impact analysis.

Verify Project Costs

The first step in the financial impact analysis is an evaluation of the proposed pollution control project. Private entities should consider a broad range of discharge management options including pollution prevention, end-of-pipe treatment, and upgrades or additions to existing treatment. Specific types of pollution prevention activities to be considered include:

- Change in raw materials
- Substitute process chemicals
- Change in process
- Water recycling and reuse
- Pretreatment requirements.

Whatever the approach, the discharger must demonstrate that the proposed project is the most appropriate means of meeting water quality standards and must document project cost estimates (EPA, 1995). If at least one of the treatment alternatives that allows the applicant to meet water quality standards would not impose substantial impacts, then they are not able to demonstrate substantial impacts and should not proceed with the analysis presented in the remainder of this workbook.

Since the most cost-effective approach to meeting water quality standards should be considered, submissions should list their assumptions about excess capacity, future facility expansion, and alternative technologies. The most accurate estimate of project costs may be available from the discharger's design engineers. These estimates can be compared to estimates available from EPA.

Calculate the Annual Costs of the Pollution Control Project

In order to perform the economic tests, the cost of the pollution control needed to comply with the water quality standards are calculated and converted to an annualized cost. Initially, pollution control costs are expressed in two parts: (1) the capital costs of purchasing and installing the equipment and (2) the yearly operating and maintenance (O&M) costs. Both the capital and O&M cost estimates should be provided by the discharger requesting relief. To assess whether the costs represent the most cost effective means of meeting the water quality standards, they should be compared to costs at comparable entities that meet the same standards. For dischargers covered by effluent guidelines, compliance costs have been calculated by the Agency and are available for comparative purposes.

Instead of paying for total capital costs in the first year of operation, these costs are typically spread out over several years. Annualizing capital costs produces the amount that will be paid each year, including financing costs. The applicant should annualize capital costs over the typical finance period for a loan at the interest rate that the applicant will pay when it borrows money. If it borrows from the parent firm, the interest charge should be equivalent to the interest charged by the parent firm. If it is impossible to determine the appropriate interest rate, the analysis should assume an interest rate equal to the prime rate plus 1%.[3]

The financial tests discussed below compare the costs of compliance to other costs and revenues of the applicant. Compliance costs and other costs and revenues should be calculated for the same year. If compliance costs are estimated assuming construction several years in the future, they should be deflated back to the year of the financial data. This can be done by assuming that the inflation rate over the last five years will continue into the future. Likewise, if costs were estimated for an earlier year, they should be inflated to current year costs. EPA (1995) provides a worksheet for calculating the annualized cost of pollution control (see Worksheet G).

Conduct Financial Impact Analysis

The purpose of the financial impact analysis is to assess the extent to which existing or planned activities and employment will be reduced as a result of meeting water quality standards. The

[3] Note, however, that entities that pay corporate income taxes may be able to deduct interest payments from their taxes. If this is the case, then the applicant should calculate the effective interest rate by multiplying the nominal interest rate by one minus the marginal corporate tax rate. (The marginal tax rate rather than the average rate is appropriate because it applies to incremental changes in the firm's tax-deductible expenses and income.) Federal marginal corporate tax rates can be found in Internal Revenue Service Publication 542. State marginal corporate tax rates are provided by the Federation of Tax Administrators, or by individual state departments of taxation or revenue. For example, suppose that the nominal interest rate is 7.5%, the corporation pays a flat corporate tax rate of 8.7% to the state, and its federal marginal tax rate is 34%. In this case, the overall marginal tax rate is 42.7% (= 8.7% + 34%), and the effective interest rate is 4.3% [= 7.5% x (1 – 42.7%)]. Therefore, the applicant should annualize capital costs at a 4.3% interest rate.

tests used are not designed to determine the exact impact of pollution control costs on an entity. Rather, they merely provide indicators of whether pollution control costs would result in a substantial impact. There are four general categories of financial tests, divided into a primary measure of financial impacts and three secondary measures of financial impacts:

- Primary Measure
  - Profit—how much will profits decline due to pollution control expenditures?
- Secondary Measures
  - Liquidity—how easily can an entity pay its short-term bills?
  - Solvency—how easily can an entity pay its fixed and long-term bills?
  - Leverage—how much money can the entity borrow?

Each type of test measures a different aspect of a discharger's financial health. The primary measure evaluates the extent to which an applicant's profit rate will change, and compares the profit level to typical profits in that industry. The secondary measures provide additional information about specific impacts that the discharger would bear if required to meet water quality standards. Profit and solvency ratios are calculated both with and without the additional compliance costs (taking into consideration the entity's ability, if any, to increase its prices to cover part or all of the costs). Comparing these ratios to each other and to industry benchmarks provides a measure of the impact on the entity.

In some cases, the tests might indicate that the discharger would remain profitable (profit) after investing in pollution control, but would have trouble borrowing the needed capital (leverage). This situation would indicate a need to work with the discharger in choosing the technology and schedule used to meet the regulations. In other cases, the tests might show that the discharger has a short-term problem with meeting the financial obligation imposed by the standards, but could handle it in the long-run (liquidity vs. solvency). This is important information when considering whether or not to grant a variance so as to allow more time for compliance.

For all of the tests, it is important to look beyond the individual test results and evaluate the total situation of the entity. While each test addresses a single aspect of financial health, the results of the four tests should be considered jointly to obtain an overall picture of the economic health of the applicant and the impact of the water quality standards requirement on the applicant's health. The results should be compared with the ratios for other entities in the same industry or activity. In addition, the ratios and tests should be calculated for several years of operations. This will allow long-term trends to be differentiated from short-term conditions.

In addition, the structure, size, and financial health of the parent firm should be considered in evaluating the impact of pollution controls on a facility. An important factor that may not be reflected in the measures shown above is the value of an applicant's product or operations to its parent firm. For example, if a facility produces an important input used by other facilities owned by the firm, the firm may be likely to support the facility even if it appears to have only borderline profitability. The results of these tests and other relevant factors, can be used to make a judgment as to the likely actions of the applicant (e.g., shut down entirely, close one or more product/service lines, shift to other products/services, not proceed with an expansion, continue operations at current levels) faced with the pollution control investment.

Since it is the discharger that will have to pay for the wastewater treatment, the financial tests presented use data about the discharger's operations. This data, however, may not be readily available, and if available, the discharger may consider the information to be confidential. It is EPA policy, however, that applications based on economic considerations must be accompanied by data that demonstrate the impacts (EPA, 1995).

If the information is not available at the discharger level, it can be estimated from the balance sheets or income statements of the firm that owns or controls the discharger. Estimates can be made in a variety of ways. One commonly used approach is to compare the discharger's sales or revenues to the firm's sales or revenues and apply this ratio to other financial factors. For example, if the discharger is responsible for 20% of its firm's revenues, than it is assigned 20% of the firm's current assets and current liabilities. In some cases, particularly with manufacturing facilities, the discharger may not sell its production directly, but may ship it to another facility owned by the same firm. In this case, the discharger's share of sales should be calculated by determining the market value of the goods produced by the discharger, using market prices for the year being analyzed.

EPA (1995) guidance describes the primary and secondary measures, with examples of specific tests to be used, and provides worksheets for calculating results (see Worksheets H, I, J, K, and L). All four primary and secondary measures should be used in the analysis.

Interpreting the Results

In most cases, interpreting the results requires comparisons with typical values for the industry. Among the sources that provide comparative information are: Robert Morris Associates' (now RMA) Annual Statement Studies, Mergent (formerly Moody's) Industry Review, Dun and Bradstreet's Dun's Industry Norms, and Standard & Poor's Industry Surveys. These sources provide composite statistics for firms grouped into various manufacturing and service industries. Although benchmarks are available for most financial tests, EPA emphasizes that the discharger should consider these benchmarks as indicators of financial health and not as definitive measures.

The financial analysis should be used to determine if there will be a substantial adverse impact on the applicant. As indicated above, the Profit Test should be considered first. The Profit Test measures what will happen to the discharger's earnings if additional pollution control is required. If the discharger is making a profit now but would lose money with the pollution control, then there is possibility of a total shutdown or the closing of a production line, resulting in lost employment and reduced local purchases by the discharger. Whether or not these impacts will be considered widespread is addressed below.

There are more complicated scenarios that involve making a judgment as to the likely impacts on the discharger, such as situations with questions regarding the timing of compliance. For example, the Profit Test may indicate that the applicant will continue to maintain profit levels typical for its industry after compliance, but the Debt/Equity Ratio may indicate that they will have trouble financing the project through debt. This problem may be solved by giving them more time to meet the regulations (a variance), so that they can restructure their debt or find alternative sources of funds.

Another possible scenario is that the discharger may shift to an alternative economic activity (e.g., manufacture another product or produce a different crop). While the applicant will not have gone out of business, this shift may result in reduced profits, employment, and purchases in the local community that should be considered. In each case, it is important to take the entire picture presented by the four ratios into account in judging whether or not the discharger will incur substantial impacts due to the cost of the necessary pollution reductions.

If, using these tests, applicants feel they have demonstrated substantial impacts should proceed to evaluation of widespread impacts, as described below. If dischargers are not able to demonstrate substantial impacts, then they must meet existing standards. The same primary and secondary tests of substantial impacts can be used to analyze the impact on a group of dischargers, as might be the case in a UAA (EPA, 1995). The difference would be, when the analysis moves to measuring widespread impacts, the impacts on the total group of dischargers would be used to measure whether or not the impacts are considered widespread (EPA, 1995).

1.4.2 Widespread Impacts

As described for public-sector entities, the financial impacts of undertaking pollution controls could potentially cause far-reaching and serious socioeconomic impacts. Conversely, adverse financial impacts experienced by the affected entities may be offset by the expenditures on pollution controls to attain water quality standards, since these expenditures do not vanish from the community but become business revenues and household incomes. Therefore, if a discharger or group of dischargers are expected to incur substantial impacts, an additional analysis must be performed to estimate the change in socioeconomic conditions that occur as a result of compliance (1995).

At a minimum, the analysis must (EPA, 1995):

- define the affected community (the geographic area where project costs pass through to the local economy)

- consider the baseline economic health of the community

- evaluate how the proposed project will affect the socioeconomic well-being of the community.

These steps are identical to those described for public sector entities (see Section 1.3.2 above). In all cases, socioeconomic impacts should not be evaluated incrementally, rather, applicants should assess their net (i.e., positive and negative) cumulative effect on the community. **Exhibit 6** provides a corollary to Exhibit 4 for private sector entities. As for public sector entities, if it is not possible to use a regional model, EPA (1995) provides a worksheet to describe (positive and negative) changes qualitatively (see Worksheet N) (e.g., considering economic stimulus resulting from expenditures on pollution controls and federal or state cost-share funding). Secondary impacts and benefits of clean water are also relevant, as described in Section 1.3.2.

Exhibit 6: Impacts from Expenditures on Pollution Controls by Private-Sector Entities

Source Category	Cost Impacts	Revenue and Wage Impacts
Industrial Facilities	▪ Industrial sector expenditures for capital, operating, and maintenance	▪ Revenues: incremental sales in sectors providing control equipment/materials such as construction, chemicals, and energy ▪ Wages: incremental wages in affected industry and sectors providing control equipment/materials
Agriculture	▪ Agricultural sector expenditures for capital, operating, and maintenance	▪ Revenues: Federal/state cost-sharing income for farmers; incremental sales in sectors providing control equipment or materials such as agricultural services ▪ Wages: incremental farm wages (associated with labor intensive controls), and wages in sectors providing control equipment/materials
Forestry	▪ Forestry sector expenditures for labor and materials	▪ Revenue: incremental sales in sectors providing control equipment/materials ▪ Wages: incremental forestry wages (associated with labor intensive controls)

Note: Cost impacts need to be matched with revenues to another sector, although these revenues may not always accrue within the project area.

1.4.3 Summary: Determining Whether Impacts are Substantial and Widespread

Using EPA (1995) guidance, states must demonstrate that the pollution control measures needed to meet water quality standards are not affordable. In addition, states will have to show that there will be widespread adverse impacts to the community or surrounding area if it is required to meet standards. EPA (1995) provides a summary checklist of the steps required in this process, and the information that will be required from states (see Table 4-1 in EPA, 1995, also updated below in **Exhibit** 7 for private sector entities). Whether or not the applicant has successfully demonstrated that substantial and widespread economic and social impacts would occur, however, will depend upon the EPA Regional Administrator's review of the application. As discussed above, environmental justice considerations are important (states have the responsibility to provide environmental protection to low-income communities and assure that applicants do not use low-income communities as an excuse not to provide pollution control).

Exhibit 7: Demonstration of Substantial and Widespread Economic and Social Impacts Checklist: Private-Sector Entities

Steps	Information That Will Be Required from Applicant
☐ 1. Demonstrate that designated use is a potential use and not an existing use.	Data from State Water Quality Assessment Documents and water quality standards regulations.
☐ 2. Demonstrate that entity will incur substantial economic impacts.	
☐ a. Identify all reasonable pollution reduction options	Information on end-of-pipe treatment, possible treatment upgrades, additions to existing treatment, and pollution prevention activities including the following: • change in raw materials • substitution of process chemicals • change in process • water recycling, reuse and efficiency • pretreatment requirements • public education.
☐ b. Evaluate costs of all reasonable pollution reduction options	Assumptions about water demand, treatment capacity, expansion plans, population growth, and effectiveness of control in reducing pollution for each option. Estimate of project costs from design engineers, costs of comparable projects in the state, or judgment of experienced water pollution control engineers.
☐ c. Identify lowest cost pollution reduction option that allows entity to meet water quality standards.	Information on treatment efficiencies for alternative pollution reduction techniques. Cost estimates for all alternatives.
☐ 3. Evaluate entity's financial health:	
☐ a. annualize pollution reduction project costs	Information on appropriate interest rates and period of financing.
☐ b. Primary Measure: profitability	Information that will allow evaluation of whether an entity will remain profitable after incurring the cost of pollution reduction including: • revenues, • cost of goods sold, • portion of corporate overhead assigned to the entity, and • total annualized pollution reduction project costs.
☐ c. Secondary measures:	
☐ solvency	Information that will allow evaluation of the entity's ability to meet its fixed and long-term obligations including: • long-term debt • current debt • net income after taxes • depreciation.

Exhibit 7: Demonstration of Substantial and Widespread Economic and Social Impacts Checklist: Private-Sector Entities

	Steps	Information That Will Be Required from Applicant
☐	liquidity	Information that will allow evaluation of how easily an entity can pay its short-term bills such as: • current assets • current liabilities • total annualized pollution reduction project costs.
☐	leverage.	Information that will allow evaluation of the extent to which a firm already has fixed financial obligations and therefore how much money it will be able to borrow including, long-term liabilities, and owner equity.
☐	4. Determine whether impacts are widespread:	
☐	a. Define community	Information on the geographical boundary of the area in which the majority of the entity's workers live and where most of businesses that depend on the entity are located.
☐	b. Evaluate effect on employment	Current unemployment, change in unemployment due to investment in pollution reduction.
☐	c. Evaluate effect on tax revenue,	Information on the likely effect on assessed value of property tax revenues if the entity must adopt pollution reductions.
☐	d. Assess impairment of development opportunities	Information on the likelihood that the need to adopt pollution reductions in the affected community would discourage other businesses from locating in the area in the future.
☐	e. Collect any relevant additional information that demonstrates widespread socioeconomic impacts.	Any additional information that suggests that there are unique conditions in the affected community that should also be considered.
☐	5. Evaluate economic benefits of cleaner water.	Information on potential benefits of cleaner water including enhanced recreational opportunities, reduced treatment costs for downstream users, and increased property values.
☐	6. Public comment and debate period.	Be prepared to supply backup information on the application to modify or change a designated use to the public.
☐	7. If substantial and widespread economic and social impacts are demonstrated, determine which pollution reduction option should be implemented.	Information on the cost and efficiency of affordable pollution reduction alternatives.
☐	8. Grant variance (i.e., when impacts driven by few pollutants) or redesignate uses.	Information on pollutant reductions and associated costs driving finding of substantial and widespread impacts.

Exhibit 7: Demonstration of Substantial and Widespread Economic and Social Impacts Checklist: Private-Sector Entities

Steps	Information That Will Be Required from Applicant
☐ 9. Criteria will be adopted to protect new uses, or a variance to the water quality standard for certain pollutants will be granted on a temporary basis.	Information on the "affordable" pollution reduction technique.
☐ 10. Effluent limits and permits will be modified.	Information on the "affordable" pollution reduction technique.
☐ 11. Re-evaluate water quality standards in three years.	Re-evaluation of costs, including new information or technology that allows attainment of the full designated uses without causing a substantial and widespread economic and social impact.

Source: See EPA (1995), Table 4-1.

1.5 Considerations Regarding Analysis of Agricultural and Septic Sources

Agricultural and septic sources of nutrients to the Bay can be classified as private and public-sector entities, respectively. However, there are some considerations for applying EPA (1995) guidance to evaluate these sources.

Agriculture

Although agricultural operations are privately owned, the primary and secondary tests described in Section 1.4 may not be applicable to farms. First, many are small family farms that may not be operated solely for business purposes. The U.S. Department of Agriculture classifies small family farms (less than $250,000 in sales) based on the operators' expectations from farming, stage in the life cycle, and dependence on agriculture: (1) limited resource, (2) retirement, (3) residential/lifestyle, (4) farming occupation/lower sales, and (5) farming occupation/higher sales farms (USDA, 2000b). USDA data indicate that a majority of farms are small operations that derive household income primarily from off-farm sources (USDA, 2000b). States should consider this reliance on other income sources -- some of which, if from sectors such as agricultural services, may benefit from pollution control requirements -- in analysis of this sector.

In addition, the agricultural industry as a whole is highly subsidized, which means that EPA guidance for evaluating private sector business impacts may be less appropriate than for other privately owned sources in the basin. Many agricultural producers do not meet the profitability requirement in EPA guidance (private sector entities must be profitable before implementing pollution controls for substantial impacts to result from such costs). Data from the BEA REIS indicate that, on average, farming in most watershed counties is not profitable, with average realized net income for the five years between 1996 and 2000 below zero for about half of the counties partially or wholly in the watershed. However, data are not publically available at the individual farm level to determine the profitability of individual operations. As stated above, EPA policy is that dischargers must provide the financial information to support use attainability analyses or variance requests. For businesses where all profits are not converted to owner salaries (e.g., corporate farms), the impact on profits can likely be tested.

Septic Sources

Controls on septic sources would be paid for by the public sector. Households with septic systems would not receive increases in user fees or taxes for these controls, but incur expenses to meet local requirements to install specific technology. Thus, the tests of substantial impact described in Section 1.3 do not apply because they are designed for a municipality (the preliminary municipal screener and benchmarks for this value indicate whether further characterization of the financial health of the community is warranted). However, states can consider the joint requirements that any (substantial) financial impacts on a sector would also have to have a widespread adverse impact on the community or surrounding area. Information on the number of households on septic systems may be indicative of whether such an impact can occur.

2. Screening Analysis for POTWs

The remaining sections of Part III describe the Chesapeake Bay Program's screening analysis, including variables for each sector and results.

For the POTW sector, control costs consist of annualized capital plus O&M costs for nutrient reduction technologies (NRT). Municipalities will pass costs not funded by assistance grants on to residential and nonresidential customers in the form of increased sewer fees. As described in Section 1, EPA (1995) guidance provides preliminary and secondary tests of whether such costs would result in substantial impacts on the public sector (the preliminary test acts as a trigger for performing the additional, more data intensive secondary test), and a list of variables to evaluate to determine if such impacts will also be widespread. Data and methods for determining if impacts will be widespread are complex, and best accomplished with regional economic models (similar to those mentioned above). Data to conduct the secondary test of substantial impact would also be difficult to collect Bay-wide. However, a screening-level estimate of what the preliminary test might indicate is possible, and can be performed as a first step in focusing additional analysis so that resources are not devoted to data collection for areas that clearly will not face any substantial impacts.

2.1 Screening Variables

The CBP constructed a screening-level estimate of what the preliminary test might indicate at the county level:

- Current residential sewer rate (household weighted average rate across POTWs in county incurring costs) plus estimated annual incremental control costs per household as a percent of county MHI.

Data regarding the percentage of fee increases that residential customers will bear would be specific to each facility, and are generally not available. Therefore, a conservative assumption that households bear 100% of fee increases can be used (for screening purposes) to generate the highest possible (i.e., most conservative) screening values. The actual portion of the rate increase borne by households can be investigated if analysis proceeds further for any particular community.

To estimate this variable, the CBP collected current sewer rate data from state, county, and municipal sources for 176 of the 297 POTWs identified as "significant" dischargers (i.e., that will require controls in Tiers 1-3). The CBP used a placeholder value of $200 for the 121 facilities for which no rate information could be located. MHI is from the 2000 Census of Population and Housing (U.S. Census Bureau, 2002), adjusted to 2001 dollars using the CPI (BLS, 2002).

To correspond with the estimated POTW costs, which reflect facility-estimated 2010 flows (including increases in 2010 capacity for some facilities that more than double current flows), per-household estimates of costs reflect estimated 2010 service populations. Households served in 2010 is derived by multiplying the number of households served in 2000 by the rate of population increase from 2000 to 2010, as projected by the Chesapeake Bay Program for the county containing the POTW. Data on population served in 2000 are from local and state sources, where available, or from the 1996 Clean Water Needs Survey (U.S. EPA, 1998) adjusted to 2000 using county-level population data from the U.S. Census. For the 37 facilities where no data are available, households served in 2000 is estimated based on the average flow (assuming 100% residential flow), average indoor use of 64 gallons per person per day, persons per household in the County from the 2000 Census, and the CBP's 2010 county population projections.[4]

In counties that have multiple POTWs incurring costs under a tier scenario, the screening variable is a service population weighted average of the individual POTW screening values. This approach can obscure some high municipal screening values among municipalities that have small population weights in the county totals. However, substantial impacts in these small municipalities are not likely to have widespread impacts if they are too small to have much influence on a county-level value. The Blue Plains WWTF in Washington, D.C. serves residents of more than one county. To calculate screening values for communities served by this facility, control costs are allocated to households in Montgomery and Prince George's Counties, MD, Washington, DC, and Fairfax and Loudoun Counties, VA, based on the contributions of each jurisdiction to total flow (MWCOG, 2002; Jones, 2003). However, costs for the 43% CSO reduction in the District of Columbia required under all Tiers are allocated to District residents only.

Similarly, control costs for nine facilities administered by the Hampton Roads Sewer District (HRSD) (Williamsburg, York, Army Base, Nansemond, VIP, Boat Harbor, James River,

[4] For 8 facilities, average 2000 flow is zero (indicating the facility was not operating by 2000 but would be operating by 2010). For these facilities, number of households served is based on average 2010 flow.

Chesapeake-Elizabeth, and West Point) are allocated to households in fourteen jurisdictions (the Counties of Gloucester, Isle of Wight, James City, King William, and York, and the independent cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg), according to the method provided by HRSD. In the city and county of Baltimore, two WWTFs (Patapsco and Back River) each serve populations in both the city and the county. Costs for those facilities are allocated to Baltimore City and County according to the percentage of flow from each facility that serves the city and the county, according to the Baltimore Department of Public Works.

2.2 Screening Results

Exhibit 8 provides a summary of the POTW screening values by tier scenario. For Tier 1, approximately 95% of the jurisdictions (counties and independent cities) have screening values in the range 0% to 1%; the remaining counties have values in the 1% to 2% range. In Tiers 2 and 3, the screening variable values are somewhat greater. Nevertheless, more than 80% of counties in both Tier 2 and Tier 3 have screening values of less than 1%.

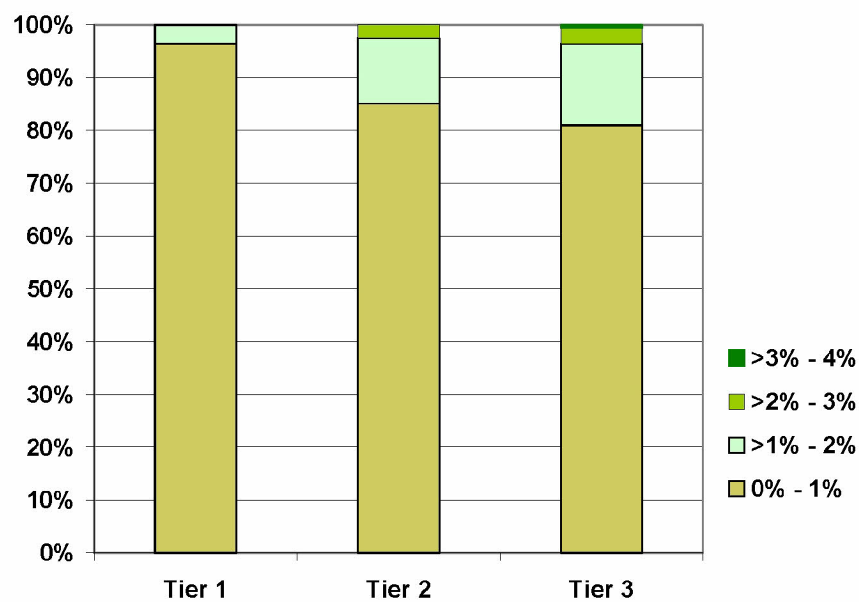

Exhibit 8: Distribution of POTW Screening Variable Values by Tier Scenario

There are four main sources of uncertainty regarding these screening results (**Exhibit 9**). The assumption that households incur 100% of incremental control costs is likely to have the greatest impact and is discussed further below. The second source of uncertainty is the use of a placeholder value of $200 for 121 POTWs for which current sewer rate data are not available. The direction and degree of bias caused by this assumption is unknown. Third, service population data are estimated for 37 facilities based on treated flows, which is consistent with the assumption that households incur 100% of costs, but may overstate the actual number households served.

Exhibit 9: Sources of Uncertainty in the POTW Screening Variable

Assumption	Direction of Bias	Comments
Residential customers bear 100% of additional costs for most POTWs.	+	Actual MPS values will be lower after accounting for costs borne by industrial and commercial users.
No real income growth through 2010	+	Actual MPS values will be lower in areas for which real personal income is forecast to grow by 2010, and lower in areas where real income growth is forecast to decline by 2010.
Number of households served is calculated based on flow for 37 POTWs where other data are unavailable.	?	MPS screening values may or may not reflect actual MPS values.
Current annual residential sewer rate placeholder of $200 for 121 POTWs where other data are unavailable.	?	MPS screening values may or may not reflect actual MPS values.

+ = assumption results in overestimating screening variable value
? = impact of assumption on screening variables is unknown.

As an example of the impact of these uncertainties, the following comparison illustrates how the values might change when corrected for the proportion of costs that will be actually borne by households. **Exhibit 10** provides data for the 34 POTWs with screening values of 1.5% or more for Tier 3. The exhibit shows the number of households used to calculate the screening variable, and the number of households implied from POTW flow. If residences will most likely pay for 100% of incremental costs, then the two estimates should be similar; large differences may indicate that nonresidential customers (i.e., businesses and industries) account for a large proportion of flow and will likely incur a proportion of incremental costs.[5] Therefore, the screening values for these facilities probably overstate the actual MPS. This appears to be the case for the majority of these facilities: the ratio of the estimate to the imputed household estimate is less than 100% for all but 5 of the facilities, and is 50% or less for 21 of the 34 facilities. The last column of Exhibit 10 shows what the screening values would be if only a portion of incremental costs (equal to the ratio) accrue to residential customers. For example, if 54% of annual costs for the Bridgeville facility in Sussex, DE, accrue to households, then the value would be 1.5% rather than 2.0%.

[5] Inflow and infiltration may also be affecting flows.

Exhibit 10: Facilities with Tier 3 POTW Screening Variable Values Above 1.5%

County	Facility Name	NPDES Number	Screening Variable Value	Number HH Served (Screening Variable)	Number HH Served (Imputed)[1]	Ratio of Screening Variable HH to Imputed HH	Adjusted Screening Variable Value
Sussex, DE	Bridgeville	DE0020249	2.0%	760	1,406	54%	1.5%
Dorchester, MD	Hurlock	MD0022730	2.7%	501	6,928	7%	0.7%
Bedford, PA	Hyndman Borough	PA0020851	1.8%	462	513	90%	1.7%
Blair, PA	Logan Township-Greenwood Area	PA0032557	2.3%	462	2,375	19%	0.9%
Blair, PA	Martinsburg	PA0028347	1.8%	1,166	2,652	44%	1.4%
Juniata, PA	Twin Boroughs Sanitary Authority	PA0023264	1.7%	633	1,954	32%	1.0%
Mifflin, PA	Brown Township Municipal Authority	PA0028088	1.7%	699	2,158	32%	0.9%
Perry, PA	Marysville Municipal Authority	PA0021571	1.6%	2,902	7,017	41%	1.4%
Schuylkill, PA	Pine Grove Borough Authority	PA0020915	1.9%	1,002	2,684	37%	1.4%
Tioga, PA	Blossburg	PA0020036	1.6%	733	1,294	57%	1.2%
Tioga, PA	Elkland Municipal Authority	PA0113298	1.6%	785	2,702	29%	0.9%
Union, PA	Gregg Township	PA0114821	2.5%	181	3,104	6%	1.5%
York, PA	New Freedom WTP	PA0043257	1.7%	608	6,661	9%	0.5%
York, PA	Stewartstown Borough	PA0036269	1.6%	434	1,575	28%	0.7%
Accomack, VA	Tangier Island	VA0067423	2.4%	459	314	>100%	2.4%
Accomack, VA	Onancock	VA0021253	1.9%	652	1,591	41%	1.2%
Amherst, VA	Lynchburg	VA0024970	1.6%	18,073	72,028	25%	1.1%
Augusta, VA	Weyers Cave STP	VA0022349	1.7%	526	634	83%	1.5%
Hanover, VA	Doswell	VA0029521	1.6%	569	25,232	2%	0.6%

Exhibit 10: Facilities with Tier 3 POTW Screening Variable Values Above 1.5%

County	Facility Name	NPDES Number	Screening Variable Value	Number HH Served (Screening Variable)	Number HH Served (Imputed)[1]	Ratio of Screening Variable HH to Imputed HH	Adjusted Screening Variable Value
Henrico, VA	Hopewell	VA0066630	2.5%	7,511	194,897	4%	0.3%
Lancaster, VA	Kilmarnock	VA0020788	2.5%	579	1,705	34%	1.7%
Mathews, VA	Mathews Courthouse	VA0028819	2.8%	186	307	60%	1.9%
Middlesex, VA	Urbanna	VA0026263	2.5%	325	382	85%	2.3%
Northampton, VA	Cape Charles	VA0021288	1.5%	791	1,021	77%	1.3%
Northumberland, VA	Reedville	VA0060712	2.3%	304	248	>100%	2.3%
Nottoway, VA	Crewe STP	VA0020303	1.6%	963	1,335	72%	1.4%
Rappahannock, VA	Remington Regional	VA0076805	1.6%	3,738[2]	3,738	100%	1.6%
Richmond, VA	Warsaw	VA0026891	2.0%	946[2]	946	100%	2.0%
Shenandoah, VA	Stony Creek STP	VA0028380	3.0%	278	1,682	17%	1.0%
Shenandoah, VA	New Market STP	VA0022853	2.1%	659	3,559	19%	1.3%
Westmoreland, VA	Colonial Beach	VA0026409	1.6%	1,803	5,357	34%	1.4%
Westmoreland, VA	Montross-Westmoreland	VA0072729	3.2%	192[2]	192	100%	3.2%
Clifton Forge City, VA	Clifton Forge	VA0022772	3.4%	706	8,071	9%	1.2%
Grant, WV	Petersburg	WV0021792	1.6%	960	4,014	24%	0.9%

1. Imputed number of households served is calculated as 2000 average flow in gallons, divided by 64 gallons of indoor water use per person per day times the average number of people per household for the county from the 2000 Census, updated to 2010 using the CBP's estimated population growth factors for each county.
2. Estimated number of households served for the screening variable MPS is imputed from 2000 flow and, therefore, the number of households served in the screening analysis is the same as the number that would be imputed from the flow. An analysis of substantial and widespread impacts may show that less than 100% of the flow is attributable to households.

Exhibit 11 maps the POTW screening variable by county for Tier 1. Values in the 1% to 2% range tend to occur in coastal counties in Virginia and Maryland. Rappahannock County, VA, has the highest Tier 1 value (1.5%).

Results for Tiers 2 and 3 are very similar. The map in **Exhibit 12** shows results for Tier 3; the map for Tier 2 is in Appendix E. In Tier 3, several coastal counties and cities along the Rappahannock River and the Eastern Shore have the highest screening values, although values are below 3% with the exception of Clifton Forge City, VA. Other areas with concentrations of MPS values above 1% include the Northwest Virginia-West Virginia region, Central Pennsylvania, and Northeastern Pennsylvania. Most of these locations (except the independent cities) have small service populations (e.g., fewer than 7,000 households each), which tends to increase the per-household cost compared to facilities that serve larger populations. Also, many of them have MHIs below $35,000.

As noted above, many of the counties with screening values greater than 1.5% may have actual MPS values that are lower (because households account for less than 100% of treated flow and, therefore, may incur less than 100% of incremental costs). Therefore, the MPS results can only indicate where substantial impacts are unlikely, and calculation of actual MPS values and secondary tests for substantial impact may produce different results.

2.3 Groundtruthing of Screening Results

To further investigate how well the POTW screening variable reflects the actual MPS value, this section provides more comprehensive analysis of the results for Allegany County, MD.

Exhibit 13 provides a summary of the estimated costs and POTW screening variable across the modeling scenarios. There are three POTWs serving Allegany County. The screening variable value is 0.8% under Tiers 1 and 2 and 0.9% under Tier 3, indicating substantial impacts are unlikely. A more detailed investigation of rates, flows, and the MPS for Tier 3 (**Exhibit 14**) produces the same result (a value of 0.7 %, also indicating substantial impacts are unlikely). Thus, under EPA guidance (1995), consideration of secondary tests for substantial impact is not necessary. Moreover, sensitivity analyses indicate that the ratio remains below 1% even if the analysis excludes anticipated grant funding equal to 50% of capital costs.

This detailed evaluation does not include review of the accuracy of the control costs and the technology selection (i.e., whether costs reflect the most cost-effective controls). Because the screening variable value is below 1% for Tier 3, even if it were calculated without the 50% grant funding, potential estimation errors most likely do not affect this result. Current sewer rates account for the largest portion of the screening variable value (the data in Exhibit 14 result in a ratio of 0.63% before adding the cost of the tier controls), and provide the greatest source of error in the screening variable. Thus, basinwide, actual MPS values may differ substantially from the screening variable values.

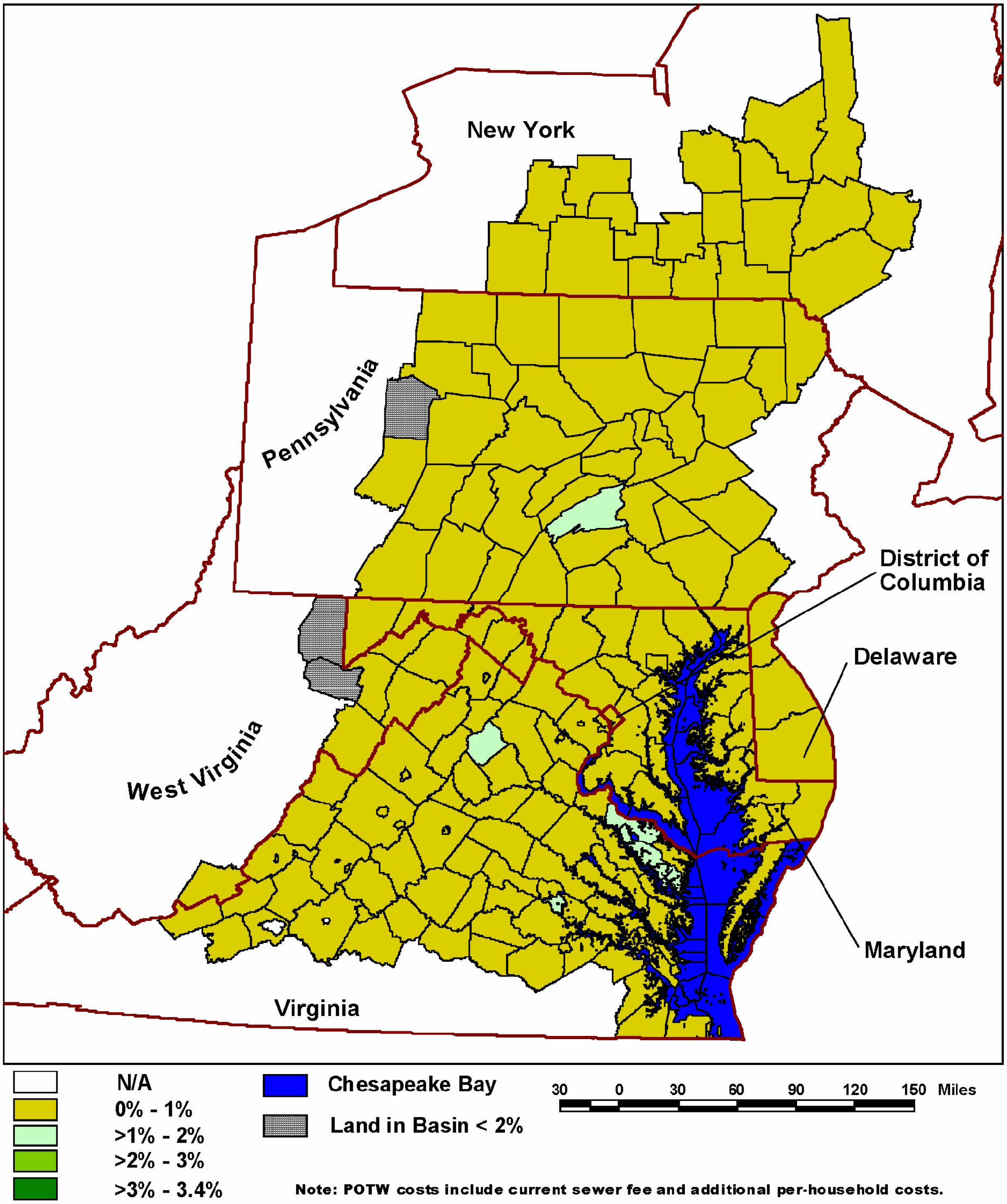

Exhibit 11: Comparison of Estimated Total Household Sewer Costs to MHI: Tier 1 (POTW Screening Variable Values)

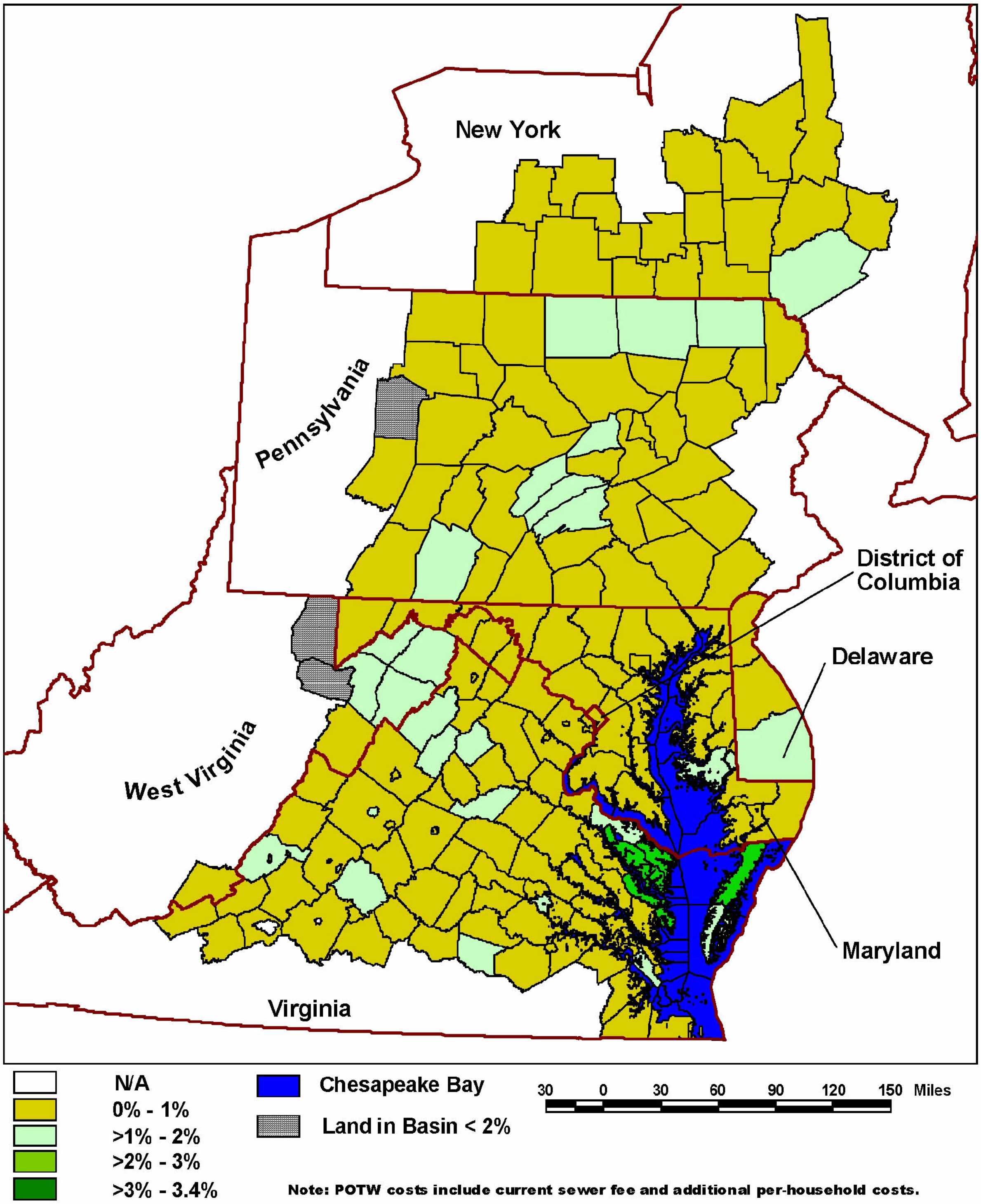

Exhibit 12: Comparison of Estimated Total Household Sewer Costs to MHI: Tier 3 (POTW Screening Variable Values)

Exhibit 13: POTW Screening Variable Data for Allegany County, MD (2001$)

Estimate	Tier 1	Tier 2	Tier 3
POTW Costs Borne by Households[1] ($/yr)	399,844	496,943	1,024,409
POTW Costs Borne by State[1] ($/yr)	242,874	252,145	533,205
POTW Screening Variable as percent of county MHI	0.8%	0.8%	0.9%

1. Households pay for 50% of capital costs and 100% of annual O&M costs. The state grant pays for the remaining 50% of capital costs.

Exhibit 14: Re-calculation of Screening Variable Value for Allegany County: Tier 3 (2001$)

Item	Georges Creek	Cumberland	Celanese
2010 Average Flow[1] (mgd)	0.67	9.60	1.02
Percent Residential Flow[2]	100%	94%	50%
2010 Households Served[3]	2,348	20,313	3,253
Tier 3 Total Capital Cost[1]	$2,846,898	$6,654,980	$7,603,522
Tier 3 O&M Cost[1]	$79,406	$250,533	$161,522
Expected Grant Funding	50%	50%	50%
Tier 3 Capital Cost Borne by Households[4]	$1,423,449	$3,127,841	$1,960,881
SRF Loan Rate	2.2%	2.2%	2.2%
Tier 3 Annualized[5] Capital Cost Borne by Households	$88,743	$195,000	$118,507
Tier 3 Annual Cost per Household[6]	$72	$21	$61
Current Yearly Sewer Rate[7,8,9]	$208	$208	$240
Estimated Annual Sewer Rate under Tier 3[10]	$280	$229	$301
Estimated 2001 MHI[11]	$32,764	$32,764	$32,764
Estimated MPS Value[12]	0.85%	0.70%	0.92%
Population-weighted Average MPS Value for County	0.74%		

1. Estimated by the Point Source Nutrient Reduction Task Force Workgroup.
2. Personal communication with R. Snyder and K. Hanft, Allegany Public Works, 2002.
3. 2000 population served escalated to 2010 levels using the Chesapeake Chesapeake Bay Program's projected growth rate for the county (1.04) and divided by 2.56 persons per household. 2000 populations based on personal communication with the Allegany County Utilities Division and the Cumberland facility.
4. Estimated by multiplying percent residential flow by total capital cost less grant funding.
5. Annualized at the state SRF rate (U.S. EPA, 2001) over 20 years.
6. Annualized cost borne by households plus the household share of annual O&M costs divided by estimated 2010 households served.
7. Source: Harford County Benchmarking Study, 2000.
8. Celanese serves Bowling Green, MD which has different sewer rates than the rest of the service population so a weighted average is used based on population.
9. Average household water usage assumed to be about 93,440 gallons per year based on 100 gpd/person (Viessman & Hammer, 1998) and 2.56 persons per household (2000 Census) to calculate Bowling Green rates.
10. Current sewer rate plus annual cost per household.
11. U.S. 2000 Decennial Census (2002) in 1999 dollars updated to 2001 dollars using the Consumer Price Index (i.e., assuming no real income growth from 1999 to 2001).
12. Estimated sewer rate under Tier 3 (in 2001 dollars) divided by estimated MHI (in 2001 dollars).

In addition, number of households served and the percent of costs that will be borne by households also influence the screening variable value. For example, residential flow accounts for 50% to 74% of average daily flow for the Celanese facility and between 58% and 100% for Georges Creek. These discrepancies may be due to how inflow and infiltration is reported (however, correcting inflow and infiltration could influence the estimated treatment costs).

Although the results for Allegany County indicate that there is no need to perform the secondary test, the CBP collected data for the secondary test to evaluate the feasibility of conducting the test. **Exhibit 15** provides the data collected to calculate values for the six indicators used to construct the secondary test score. The indicator scores, shown in **Exhibit 16**, result in a secondary test score of 2. A secondary score of 2 combined with a MPS value of less than 1.0 implies that the impact is not likely to be substantial (see Exhibit 3).

3. Industrial Point Sources

Control costs for industrial point sources include annualized capital costs and annual O&M costs for NRT such as biological nitrogen removal (BNR). These costs will be borne by establishments designated as major industrial point dischargers by the Chesapeake Bay Program.

As describe in Section 1.4, EPA (1995) guidance describes tests (i.e., profit tests and assessment of liquidity, solvency, and leverage) for evaluating whether private sector entities may incur substantial financial impacts. However, since some of this data may not be readily available (e.g., for privately owned companies), it would be difficult to conduct these tests for all industrial dischargers in the basin. Instead, it may be more cost-effective to first identify areas in which substantial financial impacts also have the potential for widespread adverse impact on the surrounding area. The current economic condition of the affected community and the role of the affected entities is considered in such an evaluation (EPA, 1995). Similar to the POTW analysis, this evaluation is best performed with a regional model. However, there may be some readily available data related to potential for widespread impacts that could serve to focus subsequent analysis.

3.1 Screening Variable for Industrial Facilities

A screening-level variable that might in indicate when widespread impacts are unlikely is the earnings in the county that are generated by the discharger. However, this data is not available from any national database because of nondisclosure requirements. What is available is the earnings derived from the industrial category that the discharger is classified in, although this will include earnings from businesses that are not affected by the tier scenarios. Therefore, the screening variable can only show where widespread impacts are unlikely because the sector that contains an affected business accounts for a small share of local earnings.

Exhibit 15: 2001 Data Used in the Secondary Test: Allegany County, MD

Item	Source	Value
Bond Rating	Allegany County FY 2003 Budget, May 23, 2002	Standard and Poor's: A– Moody's: Baa1
Net Debt[1]	Allegany County Finance Office	$47,537,740
Market Value of Property	Allegany County (http://www.gov.allconet.org/finance/presentations.htm)	$2,027,094,175
Community Unemployment Rate	BLS, Local Area Unemployment Statistics, 2002	7.6%
National Unemployment Rate	BLS, Current Population Survey, 2002	4.8%
Community MHI	U.S. 2000 Decennial Census, 2002	$32,764
State MHI	U.S. 2000 Decennial Census, 2002	$56,200
Property Tax Revenues	Allegany County Tax Office and Allegany County Finance Office	$33,680,300
Property Tax Collection Rate	Allegany County Tax Office and Allegany County Finance Office	95%

1. Allegany County component unit debt only; does not include any other component units of the Allegany County reporting entity. Includes Nursing Home portion of 1978 and 1992 bond issues.

Exhibit 16: Secondary Test Indicators for Allegany County, MD

Indicator	Secondary Indicator Ratings[1]			Score
	Weak	Mid-Range	Strong	
Bond Rating	Below BBB (S&P) Below Baa (Moody's)	BBB (S&P) Baa (Moody's)	Above BBB (S&P) or Baa (Moody's)	3
Overall Net Debt as Percent of Full Market Value of Taxable Property	Above 5%	2% – 5%	Below 2%	2
Unemployment	More than 1% above National Average	National Average	More than 1% below National Average	1
MHI	More than 10% below State Median	State Median	More than 10% above State Median	1
Property Tax Revenues as a Percent of Full Market Value of Taxable Property	Above 4%	2% – 4%	Below 2%	3
Property Tax Collection Rate	< 94%	94% – 98%	> 98%	2
Average Secondary Test Score				2

na = not applicable; S&P = Standard and Poor's Corporation; Moody's = Moody's Bond Record.
1. Weak is a score of 1 point, midrange is a score of 2 points, and strong is a score of 3 points.

The earnings data for this variable are from the Bureau of Economic Analysis Regional Economic Information System (BEA REIS), and reflect data for 1999 at the two-digit SIC level for the following industries, which contain the industrial dischargers with nutrient controls:

- Agricultural services, forestry, and fishing, including aquaculture (SIC 07-09)
- Food and kindred products and tobacco (SIC 20-21)
- Pulp and paper (SIC 26)
- Chemicals and allied products (SIC 28)
- Transportation and public utilities (SIC 40-49)
- Other manufacturing (SIC 20-39, except as assigned elsewhere).

However, not all industrial facilities will incur positive costs in Tier 3, according to the estimates developed by the NRT Cost Task Force (2002). Thus, the screening variable does not take into account sector earnings in counties that contain a significant discharger but where the estimated costs for the discharger in Tier 3 are zero. As an example, there are three significant dischargers in Chesterfield County, VA: one that is classified in food and kindred products and tobacco, one in pulp and paper, and one in chemicals and allied products. However, the NRT Cost Task Force estimate indicates that the discharger in the chemicals and allied products sector will not incur costs in Tier 3. Thus, the screening variable for this county is the percentage of earnings derived from food and kindred products and tobacco, plus earnings derived from pulp and paper.

3.2 Screening Results

Exhibit 17 provides a summary of the industrial point source screening values. Because the value of the screening variable does not depend on the tier scenario, the results are identical for all three tiers. Approximately 91% of the 187 counties where relevant subsector earnings are known have screening values in the range from 0% to 1%; an additional 3% have screening values between 1% and 5%. Only 6% of counties have affected sectors that account for 5% or more of earnings, and the affected dischargers account for even smaller shares of local earnings. The instances of relatively high indicator values are rarely in counties that have dischargers in multiple potentially affected sectors, although where this does happen, the variable reflects the combined earnings of those sectors. These results do not reflect the 8 counties with missing BEA earnings data for at least one sector containing a potentially affected discharger.

This screening analysis does not mean that the counties with higher variable values will experience widespread impacts. It also does not indicate whether any dischargers would even incur substantial impacts. It only indicates where the broad, multi-firm industries that contain a discharger are too small to contain single firm capable of having widespread impacts on economic conditions such as total employment, output, or tax revenues. Therefore, it is possible that the counties with high values will not experience substantial and widespread impacts. For example, the county with the highest screening value is Bradford, PA (26.6%). The annual Tier 3 control cost for the industrial discharger in that county is less than $6,000. If the discharger is large enough to have a widespread effect on the local economy, this annual cost would not have a substantial impact on its financial status. If, however, the company is small enough that a $6,000 annual cost increase would have a substantial financial impact, then it probably accounts for only a very small share of the 26.6% of earnings in the industrial category it falls under. Thus, it is not likely to have a widespread impact.

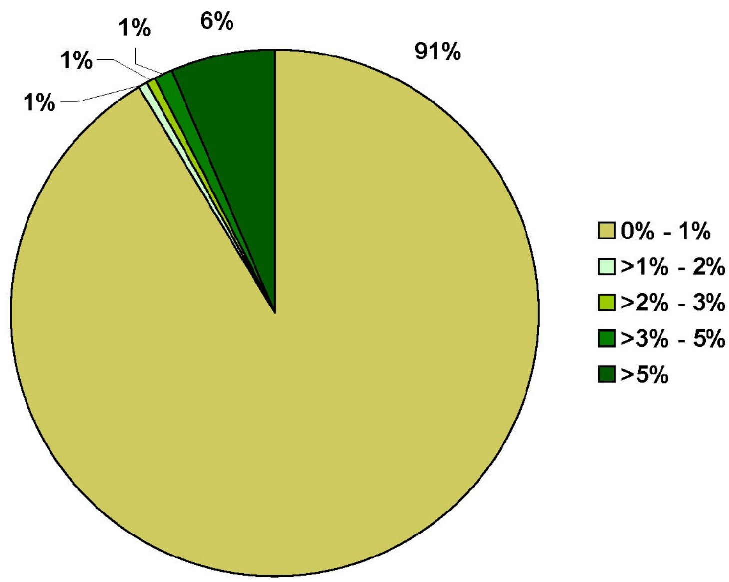

Exhibit 17: Distribution of Industrial Point Source Screening Variables

To determine the impacts of nutrient control costs, an analysis of substantial and widespread impacts would be needed for the counties with higher screening variable values as well as those with missing values. Such an analysis would consist of evaluating the financial impacts on the discharger and, if determined to be substantial, whether there would also be widespread adverse impacts to the community (U.S. EPA, 1995).

The map in **Exhibit 18** shows the values of the screening variable for widespread industrial sector impacts. The highest values occur in scattered locations throughout the watershed, although several adjacent counties in east-central Pennsylvania and northern Maryland have indicator values in the higher portion of the observed range. The screening variable value is missing for the counties that have incomplete BEA data. Therefore, they appear as white (N/A) on the map.

3.3 Groundtruthing of Screening Results

To further investigate how well the industrial discharger screening variable reflects the likelihood of widespread impacts, this section provides more comprehensive analysis of the results for Allegany County, MD.

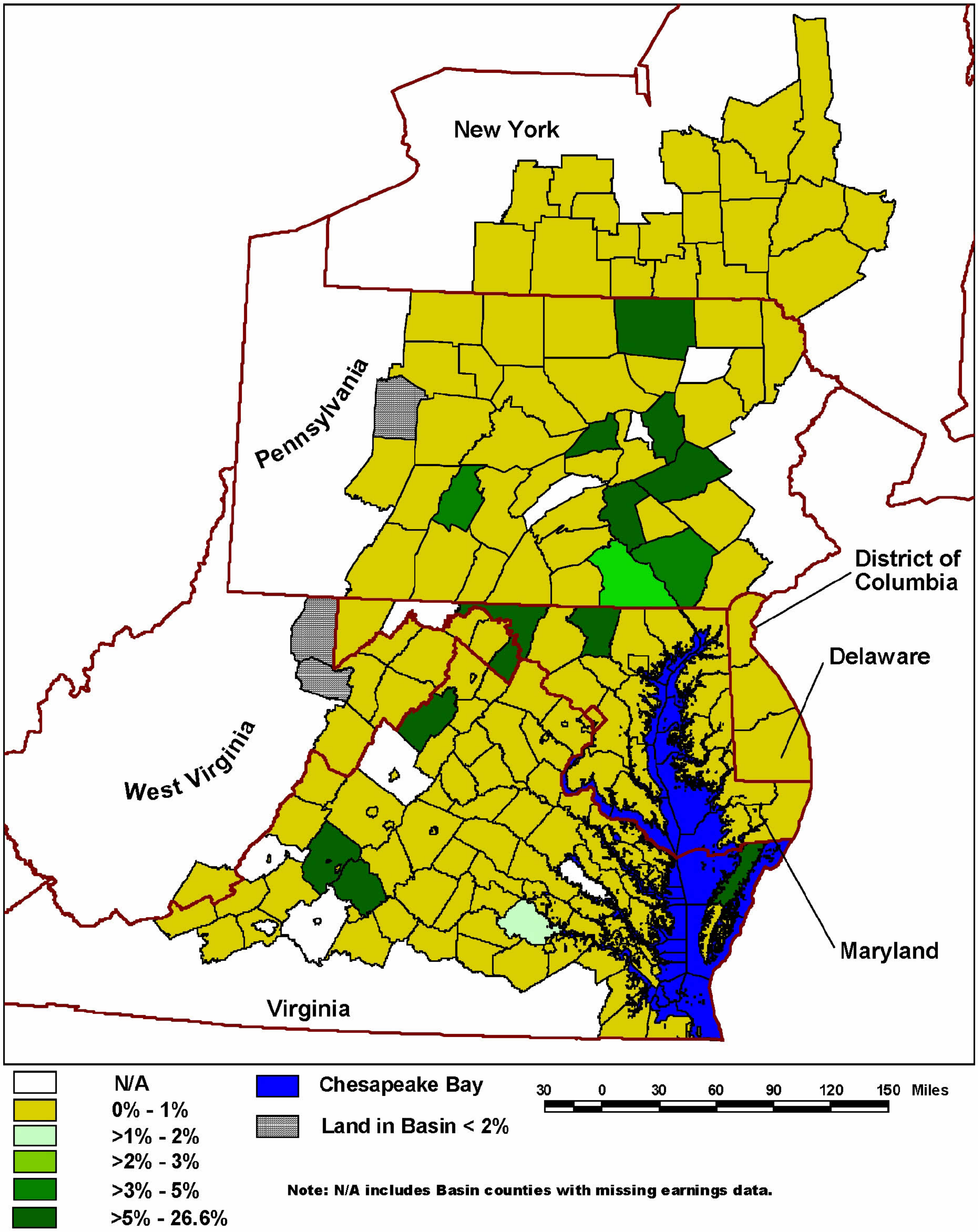

Exhibit 18: Comparison of Earnings from Industrial Discharger Category to Total Earnings

There is only one industrial discharger in Allegany County that would incur compliance costs under Tier 3. The affected discharger is the Upper Potomac River Commission (UPRC, or the Commission), which is in SIC 2621 (pulp and paper). Thus, the screening variable would consist of the percentage of earnings derived from the pulp and paper sector by place of work in 1999. However, the BEA did not disclose data for earnings from pulp and paper in Allegany County in 1999 (or for any year between 1996 and 2000) and, therefore, the screening variable for widespread impact potential is not defined. This indicates that either there were fewer than three firms in the pulp and paper sector, or that one firm accounted for over 80% of earnings. Based on the results of the screening variable, the potential for widespread impacts in Allegany County is unknown (i.e., there could be one large facility that contributes substantially to earnings, but there could also be just one or two small firms). Therefore, the possibility of widespread impacts cannot be ruled out; a more comprehensive analysis is needed to determine whether impacts would indeed be substantial and widespread.

The UPRC operates the Westernport wastewater treatment facility, which treats primarily industrial waste from the Mead-Westvaco Corporation's Luke Mill (approximately 98% of flow) and municipal sewage from the towns of Westernport and Luke, Maryland, and Piedmont, West Virginia. Estimated costs for this facility are shown in **Exhibit 19**. These costs would most likely be passed on to the mill.

Exhibit 19: Estimated Costs for the Upper Potomac River Commission (2001$)

Scenario	Capital	O&M	Total Annualized
Tier 1	$0	$0	$0
Tier 2	$0	$0	$0
Tier 3	$0	$109,197	$109,197

Thus, the first step in the comprehensive analysis is to test the screening analysis results by assessing the importance of the pulp and paper industry in Allegany County. According to the 1997 Economic Census, there is only one establishment involved in paper manufacturing in Allegany County. This establishment employs between 1,000 and 2,499 full-time and part-time workers, but the Economic Census does not disclose data on payroll or sales and shipments. The Allegany County Department of Economic Development (2002), however, reports that the paper company Westvaco employs 1,500 people in the county, or about 5% of the total number of workers employed. Westvaco company documents indicate that the company operates eight paper mills in the United States, including one in the town of Luke in Allegany County.

Plant-specific data on sales and profits for the Luke paper mill are unavailable from the company's published financial report. However, the paper segment of Mead-Westvaco generated $1.1 billion in sales and $50.8 million in operating profits in 2001; $1.2 billion in sales and $140.6 million in operating profits in 2000; and $1.1 billion in sales and $62.0 million in operating profits in 1999. The nutrient control costs shown in Exhibit 19 for the facility operated by the UPRC are very small compared to these profits. Thus, it is unlikely that these costs would have a substantial financial impact on the facility.

Given that substantial impacts are unlikely for this facility, the evaluation of widespread impacts is not necessary. However, had the earnings data been available to calculate the widespread indicator, it could have misleadingly shown potential for impact (because a large share of earnings in the county may be attributable to this sector). This implies that the widespread indicator alone (or the inability to calculate an indicator value in some cases) is not sufficient as indication of the potential for both substantial and widespread impacts.

4. FORESTRY

Controls for nutrient pollution from forest harvest sites consist of BMPs to reduce erosion and sediment runoff on harvest sites. The costs of implementing BMPs will be borne by logging operations and other private sector entities involved in timber extraction.

As discussed in Section 1.4, EPA (1995) guidance describes tests (i.e., profit tests and assessment of liquidity, solvency, and leverage) for evaluating whether private sector entities may incur substantial financial impacts. However, these tests require data that are not readily available for all the forestry operations in the basin. Thus, it would not be a worthwhile analysis to screen for potential substantial impacts. Additional analysis must be performed to demonstrate that any substantial impacts would also result in widespread adverse impacts on the community (EPA, 1995). This evaluation may be best performed with a regional model. However, there may be some readily available data related to potential for widespread impacts that could serve to focus subsequent analysis.

4.1 Screening Variable for Forestry

Although the tests of substantial and widespread impact listed in EPA (1995) guidance are not readily constructed for entities involved in timber harvesting in the Bay watershed, a screening variable can be constructed to narrow down areas that are unlikely to experience such impacts. For example, small shares of earnings from forestry and related sectors may indicate that any impacts would not result in widespread adverse impacts on a community (because it does not rely on those sectors for earnings). Therefore, the Chesapeake Bay Program constructed a screening variable defined as earnings from forestry plus estimated earnings from the logging sector as a percent of all earnings in the county.

The earnings data for this variable are from the BEA REIS, and reflect 1999 earnings by place of work. REIS provides data on earnings from forestry and from lumber and wood products except furniture, which includes logging as well as sawmills, manufacturers of lumber, prefabricated wood buildings, wood containers, and other wood products. If the screening variable included earnings from the entire lumber and wood products sector, it would tend to overstate the importance of forestry and logging. Thus, the screening variable includes earnings from forestry plus a portion of the earnings from lumber and wood products. The proportion is from the 1997 Economic Census, which indicated that nationally, logging subsector payroll equals 10.8% of the total payroll from lumber and wood products (U.S. Census Bureau, 2000).

4.2 Screening Results

Exhibit 20 provides a summary of the screening variable values. Because the value of the screening variable does not depend on the tier scenario, the results are identical for all three tiers. Estimated earnings from forestry and logging account for less than 1% of total earnings in 95% of jurisdictions. In only 1% of jurisdictions does the indicator value exceed 2%. The maximum value of 2.59% occurs in Buckingham County, VA. This result suggests that widespread impacts due to forestry BMPs are unlikely in most areas, regardless of whether costs impose substantial impacts on businesses. Thus, a finding of substantial and widespread impact based on the forestry BMPs is unlikely to occur.

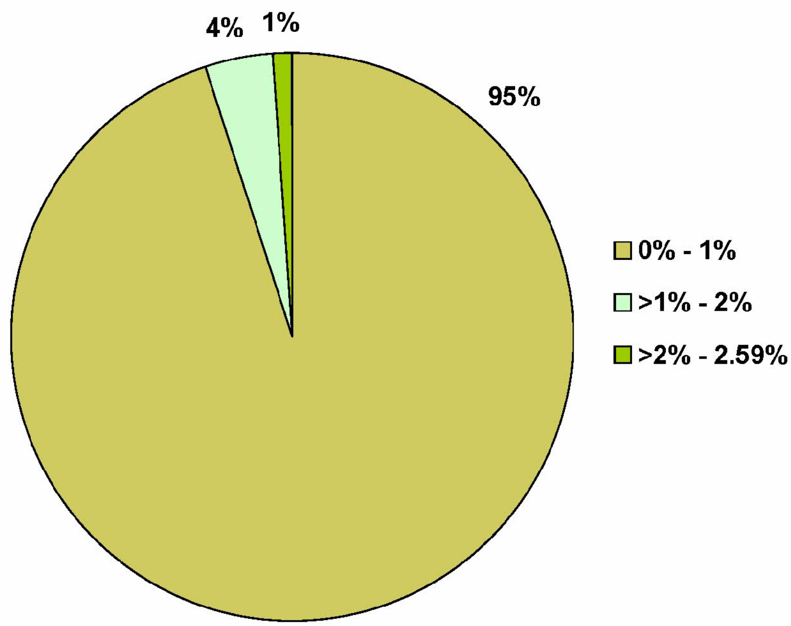

Exhibit 20: Distribution of County Values for Forestry Earnings as a Percent of All Earnings

The map in **Exhibit 21** shows that the counties with the highest screening variable values are scattered in central Pennsylvania, central and coastal Virginia, and most of the West Virginia counties in the watershed. The two counties with values in excess of 2% are Buckingham, VA (2.6%) and Snyder, PA (2.2%).

The BEA's nondisclosure policies result in some uncertainty regarding these screening results. As reported in Section 2.4, the BEA does not disclose earnings data when there are just one or two firms in a sector, or when one firm contributed more than 80% of the earnings in a sector. The BEA did not disclose forestry earnings data for 95 of the 197 Basin counties in 1999. State-level percentages, which are disclosed for all states except Delaware and West Virginia, range from 0.05% to 0.2%, indicating that the degree of bias resulting from undisclosed data is likely to be small. Earnings data from slightly larger sector breakouts support this notion. For instance, earnings from forestry, fishing,

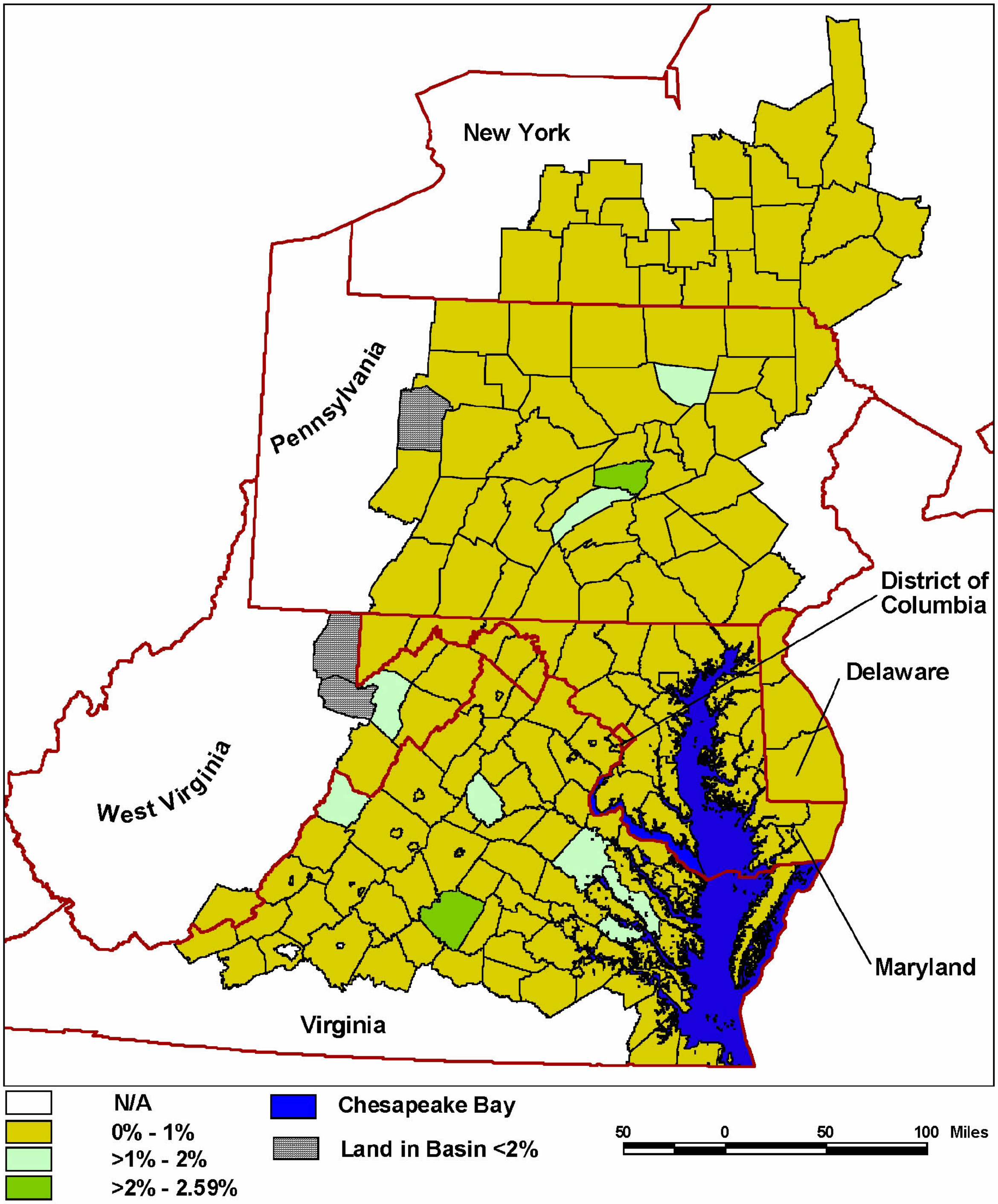

Exhibit 21: Comparison of Forestry and Logging Earnings to Total Earnings (Forestry Sector Screening Variable Values)

and the BEA "other" category (U.S. citizens employed by international organizations and foreign embassies), or FFO, are disclosed for 16 of the 95 counties where disaggregated forestry earnings data are not available; earnings from this larger sector range from 0.01% to 2.0%, with an average of 0.03%. Earnings from an even larger sector, agricultural services combined with forestry, fishing and other (ASFFO), are disclosed for an additional 42 counties, and range from 0.1% to 2.8% with an average of 0.5%. State-level data from Maryland, the District of Columbia, Pennsylvania, New York, and Virginia indicate that forestry accounts for at most 70% of the combined earnings of FFO and at most 3% of the combined earnings of ASFFO (state-level data on forestry earnings in Delaware and West Virginia are not disclosed and thus these ratios cannot be calculated for those states). Thus, the bias introduced by the nondisclosure of forestry earnings data is likely to be small.

4.3 Groundtruthing of Screening Results

To further investigate how well the forestry sector screening variable reflects the likelihood of widespread impacts, this section provides more comprehensive analysis of the results for Allegany County, MD.

The screening variable value for Allegany County rounds to zero, indicating that substantial and widespread impacts due to forest harvest BMPs would be extremely unlikely. Forestry and estimated logging accounted for 0.01% of all county earnings in 2000, demonstrating that impacts on this sector are not likely to change the economic variables that are indicative of widespread impacts.

5. Screening Analysis for Agriculture

Controlling nutrient pollution from agricultural operations requires BMPs including forest buffers, grass buffers, wetland restoration, retirement of highly erodible land, tree planting, soil conservation and water quality plans, cover crops, streambank protection, nutrient management plans, grazing land protection, animal waste management systems, yield reserve (i.e., enhanced nutrient management planning), carbon sequestration, export of excess nutrients, and conservation tillage. The costs of the BMPs will be paid by farming operations involved in crop and livestock production, and by state and federal governments through agricultural BMP cost-sharing and grant programs.

5.1 Screening Variables

Although data required for the analysis of substantial and widespread impacts on agricultural operations are not readily available, screening variables can be constructed to narrow down areas that are unlikely to experience such impacts. For businesses where all profits are not converted to owner salaries (e.g., corporate farms), the impact on profits can be tested:

- BMP costs as a percent of net cash return (NCR) from agricultural sales plus government payments ("NCR screening variable").

However, data are not readily available to construct this ratio for the individual farms for which such a business indicator would be appropriate. County level data including the NCR may not provide an accurate indication of the potential for impacts. Nationally, 80% of farms are small family farms that have very low average net income (less than $5,000) from the farm operation (USDA, 2000b). Many of the these farms lose money on farming, but farm households have higher incomes and greater wealth than the average U.S. household (USDA, 2002). Data on sales and corporate ownership reveal that most farms in the Bay watershed are small, unincorporated farms. For example, the USDA National Commission on Small Farms defines small farms as those grossing less than $250,000 annually in agricultural sales (USDA, 2000b), and small farms account for more than 85% of farms in 149 out of the 168 counties with more than one farm that are partially or wholly in the watershed (28 counties, primarily the independent cities of Virginia, had no farms, and one additional independent city had one farm, according to the 1997 Census of Agriculture). Similarly, unincorporated farms account for more than 90% of the farms in 147 of the 168 counties with more than one farm. In addition, according to the 1997 Census of Agriculture, approximately 50% of the farms in the Chesapeake Basin counties were unprofitable (total production expenses exceeded the market value of agricultural products sold, resulting in negative net cash return).[6] Within the 168 counties with more than one farm, the percentage of farms with negative net cash return ranged from 23% (Worcester, MD) to 74% (Warren, VA and Fairfax, VA), and was over 50% for 104 counties (see Exhibit C-4 in Appendix C). Because many farms are unprofitable to start, which means that there is no basis for claiming substantial and widespread economic and social impacts will occur from meeting water quality standards, the results of the screening analyses for agriculture, and the maps in particular, should be used with caution.

The NCR screening variable reflects EPA (1995) guidance for evaluating impacts on private entities by calculating control costs as a percentage of pre-tax profits. EPA (1995) indicates that profits should be measured as business income minus expenses, including depreciation and changes in net inventories (i.e., the value of a net inventory increase should be added to profit or the value of a net inventory decrease should be subtracted). A proxy for profit at the county level is net cash return from agricultural sales (NCR) plus government payments, from the 1997 Census of Agriculture (USDA, 2000a). NCR is the market value of agricultural products sold minus cash operating expenditures.[7] Because these expenditures can include the farm owner's own income, low profits may understate the amount of income the farmer actually receives from the business.

EPA (1995) recommends that profit tests on private entities be based on three consecutive years of profit data because of potential variability in profits from year to year. However, Census of Agriculture data are only available every five years (e.g., 1987, 1992, 1997). In addition, annual data on realized net income from the BEA REIS cannot be used to impute net cash return for years other than 1997 because the two data series reflect different definitions and data sources. However, REIS data do indicate that realized net income in 1997 was lower than average for

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[6] Net cash return does not include depreciation, inventory changes, or government payments, except for receipts from placing commodities in the Commodity Credit Corporation (CCC) loan program.

[7] For this indicator, NCR and government payments are prorated for the proportion of agricultural land in the county that lies in the Bay watershed (see Appendix B for details). The implicit assumption in this adjustment is that net farm income is distributed evenly over the agricultural land in a county.

most counties in the watershed between 1996 and 2000. If the same trend holds true for NCR, then the screening variable based on 1997 NCR will tend to overstate the potential for impacts.

As a measure of profit, NCR is incomplete because it does not account for depreciation, inventory changes, or government payments [other than receipts from placing commodities in the Commodity Credit Corporation (CCC) loan program]. To compensate for the lack of government payments, non-CCC government payments are added. However, the Census of Agriculture does not release data on depreciation or inventory changes.[8]

Two additional variables can help to characterize BMP costs relative to sales in farm subsectors. As with the other screening variables, these variables only show areas where costs are not likely to meet the criteria for having substantial and widespread impacts:

- Crop BMP costs (including a portion of hay crop BMP costs) as a percent of crop and hay sales

- Livestock BMP costs (plus a portion of hay crop BMP costs) as a percent of livestock and livestock products sales.

Data for crop and livestock-related sales are the "market value of agricultural products sold" from the 1997 Census of Agriculture (USDA, 2000a), inflated to 2001 dollars using USDA price indices (USDA, 2001).[9] Hay BMP costs will accrue to both the crop sector (where hay is grown for sale) and the livestock sector (where hay is grown for onsite use). Therefore, these costs are distributed between the crop and livestock sectors according to the percentage of sales derived from each sector within the county. All hay sales, however, are included in the crop sales variable because hay grown by livestock operations is more likely to be used on the farm for feed and bedding rather than sold in the market.

Comparison of BMP costs to household income may also provide some indication of where substantial impacts are unlikely:

- Mean per-farm BMP costs as a percent of estimated MHI ("MHI screening variable").

Mean per-farm costs are total county-level BMP costs divided by the 2010 projection of the number of farms within the watershed portion of the county. County MHI is from the 2000 Decennial Census (U.S. Census Bureau, 2002), adjusted to 2001 dollars using the Consumer Price Index (BLS, 2002). For individual counties, farm MHI may be larger or smaller than

[8] The Conservation Reserve Program and Wetlands Reserve Program funding is not included in the adjusted NCR estimate to avoid double-counting these payments, first as income and again as BMP cost offsets.

[9] The county-level data are prorated to reflect the portion of agricultural land in the county within the watershed, as in the NCR indicator; however, agricultural sales may or may not be distributed evenly over the agricultural land within a county.

county MHI; however, nationwide, MHI for farm households is larger than MHI for all households (USDA, 2002).

Note that the household cost variable is not based on EPA guidance—EPA (1995) provides profitability tests for businesses. Consequently, there is no benchmark for determining what percentage of total household income the business-related expenses could equal before imposing substantial impacts; benchmarks for public sector MPS screener values do not apply to business-related expenses. Thus, this variable can only identify when BMP costs are small relative to household income.

The four screening variables described above may help to narrow down areas where substantial impacts are unlikely. To help identify where substantial impacts would not also be widespread, the relative importance of the agricultural sector the local economy can be calculated:

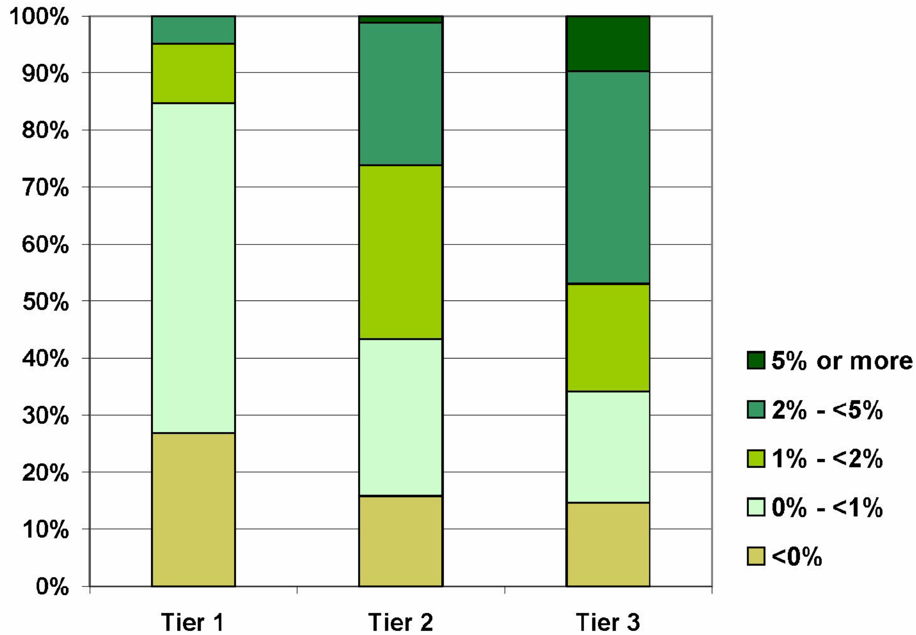
- Earnings from agriculture and related sectors in the county as a percent of all earnings in the county.

For this variable, the earnings data are from the BEA REIS (BEA, 2001) and reflect 1999 earnings by place of work (i.e., they are based on earnings made by people who work within a county rather than by people who live within a county). The ratio includes earnings from sectors upstream (agricultural services) and downstream manufacturing (food and kindred products, tobacco) to account for potential impacts on sectors that depend on farming. However, the inclusion of these additional sectors potentially makes this screening variable more ambiguous. Upstream sectors may see a rise in business activity due to implementation of BMPs; the effects on downstream sectors are also difficult to determine because many food processing businesses may receive inputs from outside the watershed or also benefit from improving Bay water quality (i.e., seafood producers in coastal counties). Therefore, results for this screening variable are also shown without earnings for the related sectors to test the sensitivity of including those sectors.

5.2 Screening Results

This section contains results for the crop sales, livestock sales, and MHI screening variables. Results for the NCR screening variable are not discussed (values are reported in Appendix C) because NCR is a poor measure of farm profitability and the presence of subsidies distorts financial conditions such that a standard analysis of private business impacts is infeasible. Furthermore, most of the operations in the watershed are not strictly business operations; they are small, unincorporated "family farm" operations where off-farm income often subsidizes farm operations. Therefore, at the county level, this variable does not provide much information

Exhibit 22 shows the distribution of values for the crop sales screening variable by tier scenario. Under Tier 1, 85% of counties have values below 1%, which means county-wide BMP costs equal less than 1% of annual crop and hay sales. More than 25% of counties have values below zero, which indicates net cost savings or net revenue from cost-share programs. In Tier 2, approximately 74% of counties have screening variable values below 2% and costs remain less than 1% of sales for more than 40% of counties. In Tier 3, variable values remain below 2% for about half of the counties.



Negative values indicate a cost savings compared to the 2000 Progress scenario.

Exhibit 22: Distribution of Crop Screening Values by Tier Scenario

Maps in **Exhibits 23** (Tier 1) and **24** (Tier 3) illustrate the shift in screening variable values across the tier scenarios; the map for Tier 2 is in Appendix D. In Tier 1, the highest values occur in or near West Virginia. In contrast, net cost savings accrue to much of central Virginia and coastal Maryland, primarily because of federal and state incentive payments for implementation of certain BMPs (in addition to maintenance payments and installation grants) in those states. Some net cost savings persist in Tier 3, particularly in Maryland, again due to incentive payments. Two counties, Cameron County in Pennsylvania and York County in Virginia, appear white because the Census of Agriculture does not report crop sales for those counties.

The screening variable values based on livestock sales (**Exhibit 25**) tend to be higher than the variable values based on crop sales across all tier scenarios. Approximately 71% of counties have values below 1% in Tier 1, and a few counties have values in the 2% to 5% range or higher. In Tier 2, almost 50% of counties have variable values less than 1%; in Tier 3 this share falls to 30%. There are higher proportions of counties with the higher values compared to the crop sector results.

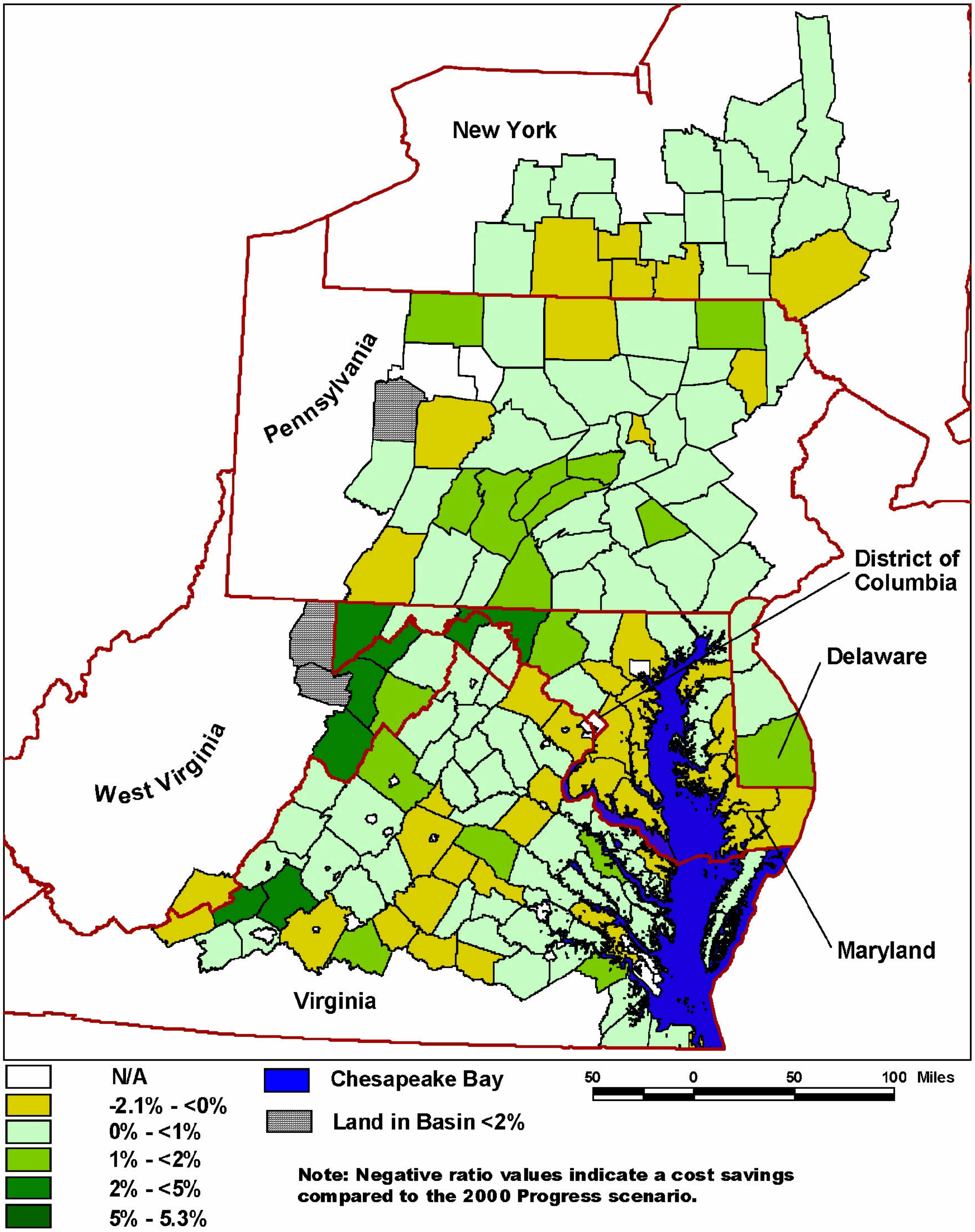


Exhibit 23: Comparison of Crop and Portion of Hay BMP Costs to Crop and Hay Sales: Tier 1 (Agricultural Sector Screening Variable Values)

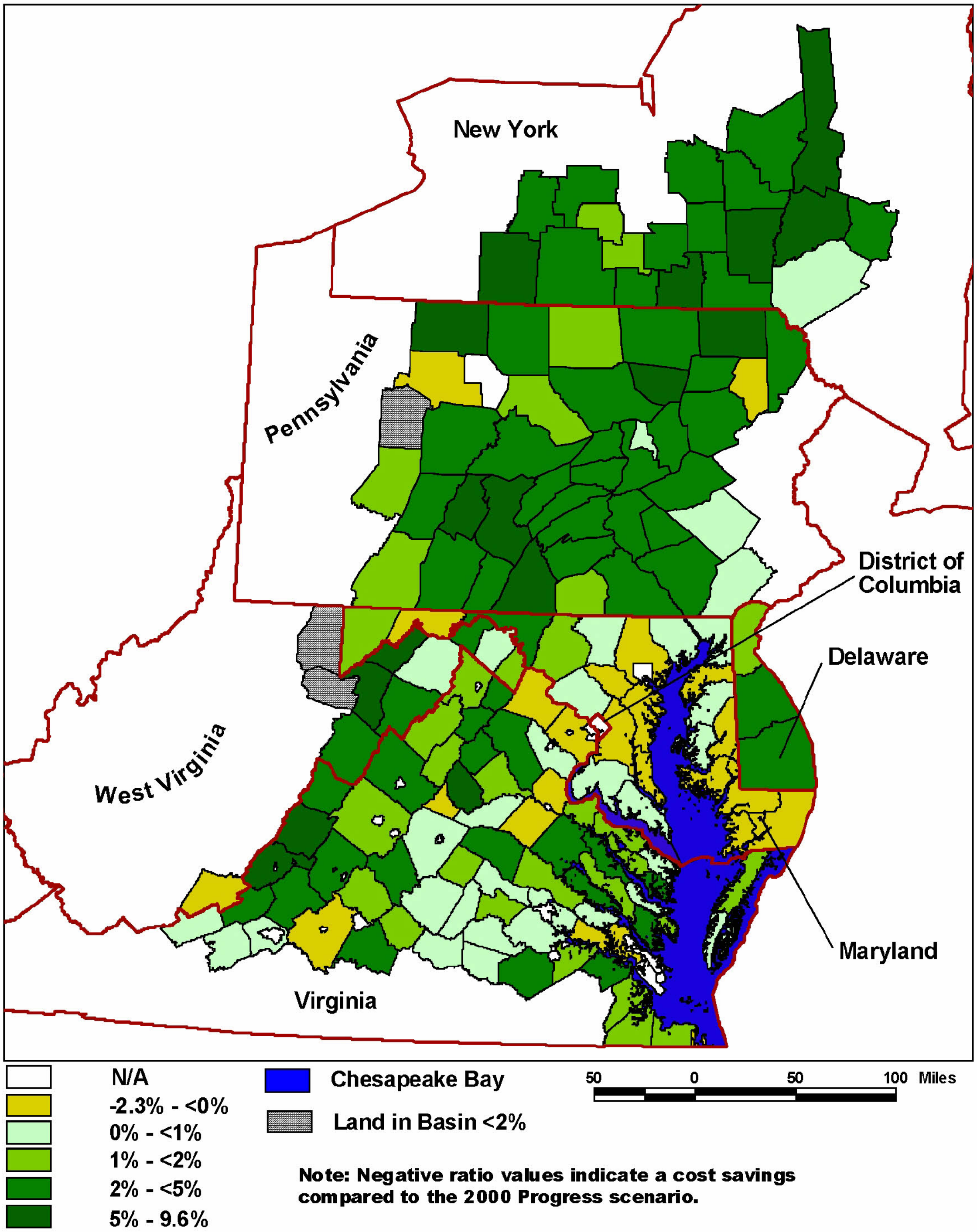
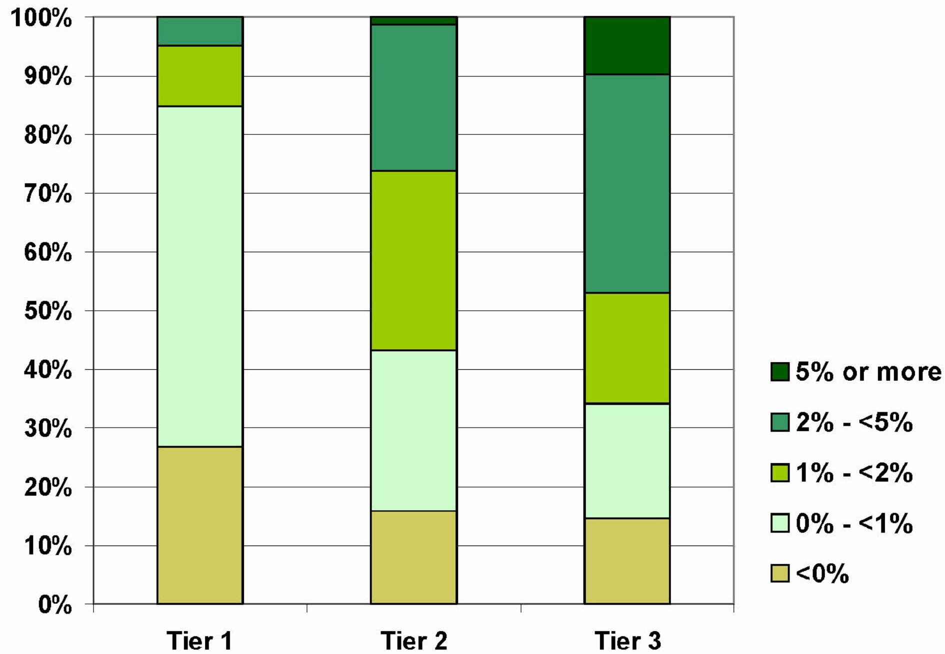


Exhibit 24: Comparison of Crop and Portion of Hay BMP Costs to Crop and Hay Sales: Tier 3 (Agricultural Sector Screening Variable Values)



Negative values indicate a cost savings compared to the 2000 Progress scenario.

Exhibit 25: Distribution of Livestock Screening Values by Tier Scenario

Regional maps for Tier 1 (**Exhibit 26**) and Tier 3 (**Exhibit 27**) illustrate how the screening variable values change across the compliance scenarios; the map for Tier 2 is in Appendix D. The largest shift occurs in Virginia, where the variable for many counties is relatively small or even negative in Tier 1, but exceed 5% in Tier 3. This shift primarily reflects a large increase in BMP costs for pasture land such as stream protection and grazing land protection. Other areas with higher Tier 3 screening values include watershed counties in New York, northern and western Pennsylvania, and West Virginia. Unlike Virginia, the higher screening variable values in Pennsylvania are also attributable to higher implementation of animal waste system and manure exporting BMPs, which account for half of private livestock BMP costs in Tier 3. In New York animal waste system BMPs account for about one-third of private livestock BMP costs in Tier 3. In Virginia and West Virginia, the major cost driver is BMPs on pasture land; animal waste system and manure export BMPs account for just 10% of private livestock BMP costs in Virginia and 5% in West Virginia.

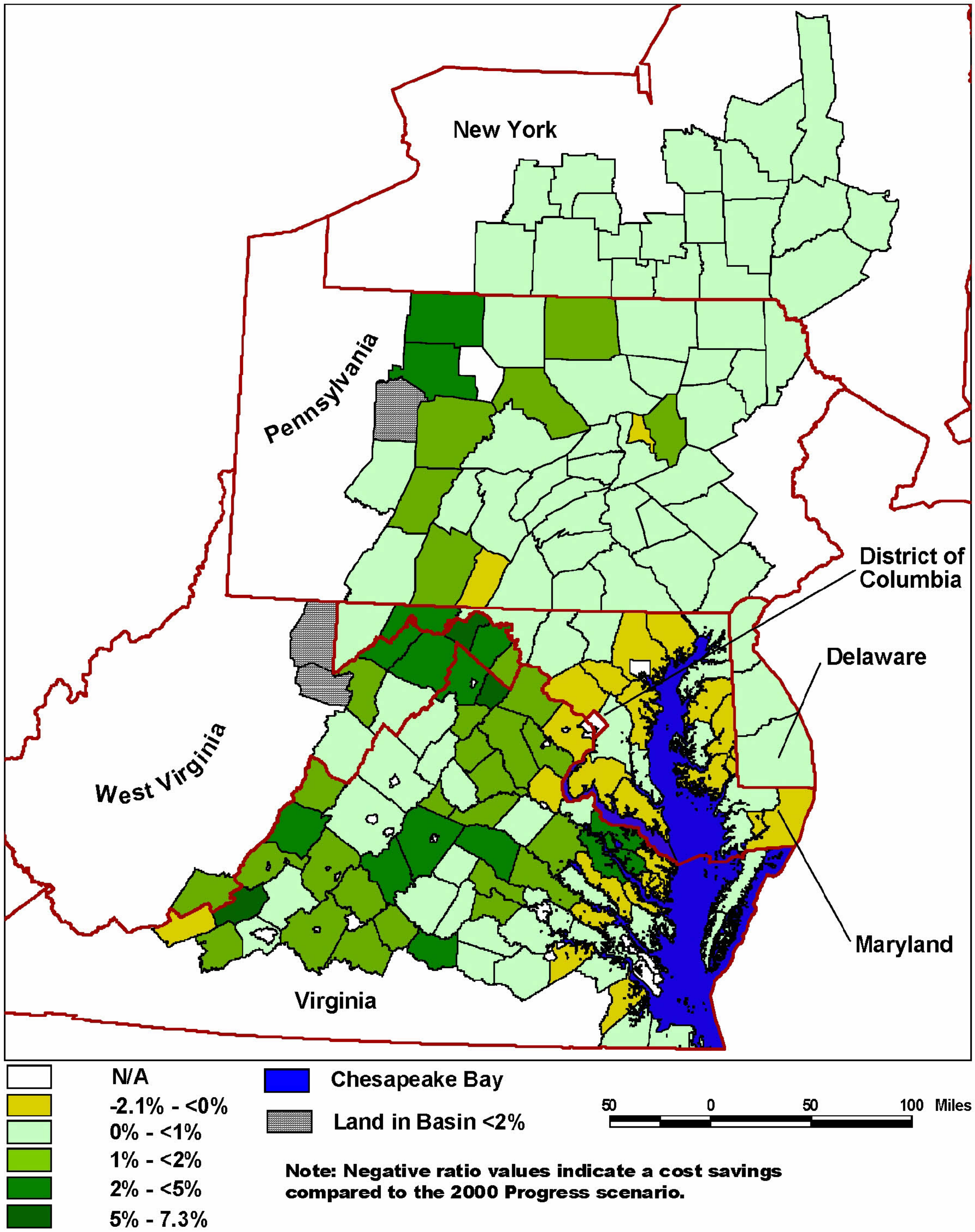


Exhibit 26: Comparison of Livestock and Portion of Hay BMP Costs to Livestock Sales: Tier 1 (Agricultural Sector Screening Variable Values)

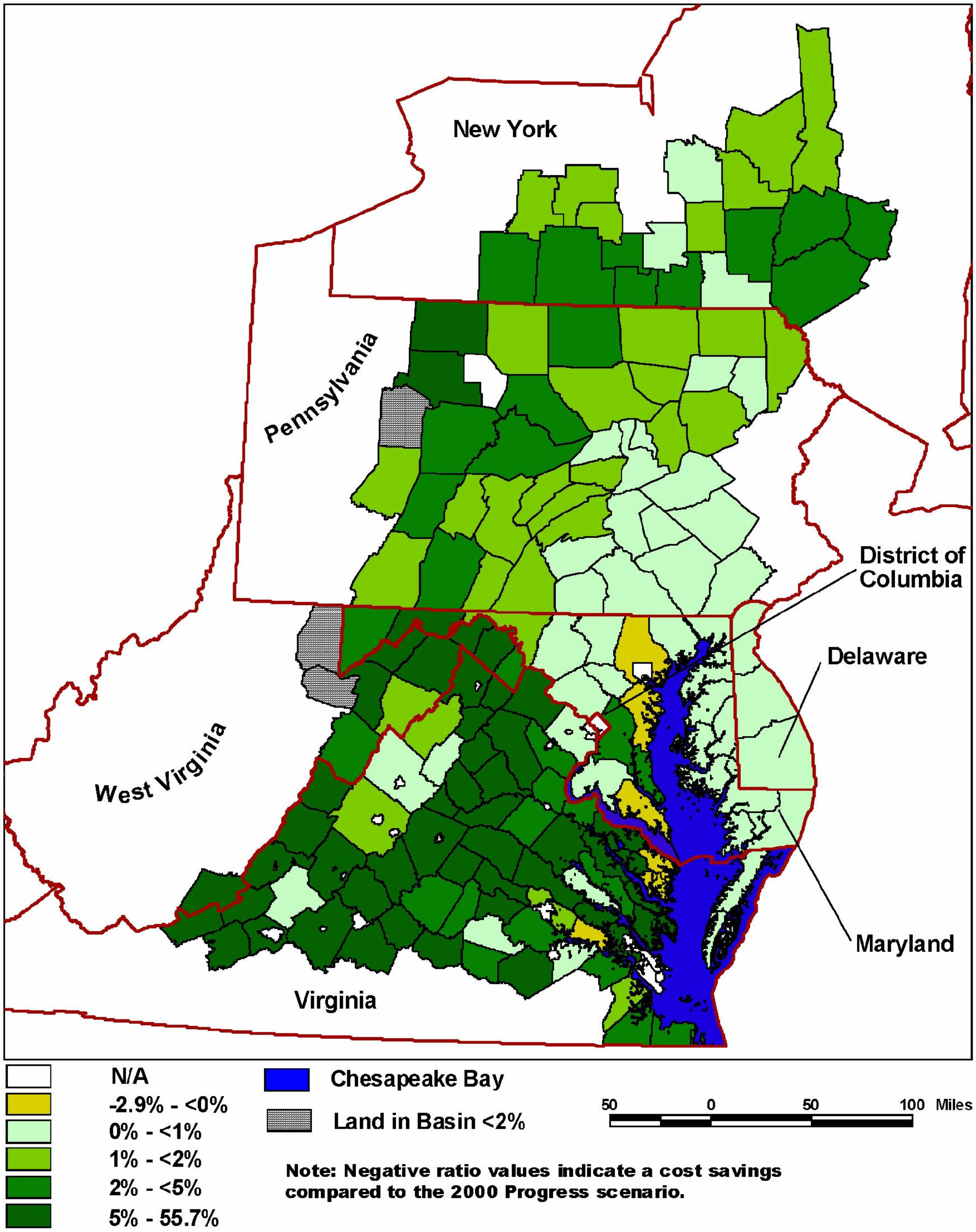


Exhibit 27: Comparison of Livestock and Portion of Hay BMP Costs to Livestock Sales: Tier 3 (Agricultural Sector Screening Variable Values)

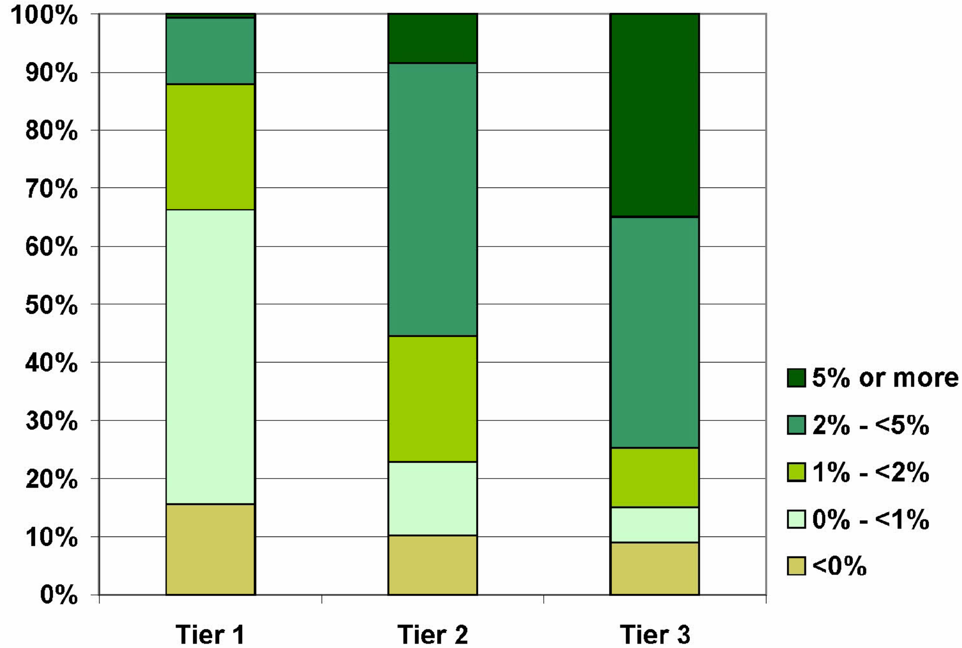
Thus, checking the accuracy of pasture BMP costs is the key validation issue. The higher screening variable values are almost entirely caused by high costs for BMPs on pasture land (streambank protection with and without fencing, grazing land protection, riparian forest buffers on pasture, farm plans on pasture) rather than other livestock BMPs, such as animal waste management and exporting manure out of areas with excess nutrients. This result raises the question of whether the pasture BMP costs in the screening analysis overstate costs. Given the heterogeneous nature of the BMPs (e.g., for grazing land protection) and their uneven application, it is possible that controls need only be applied to an unknown fraction of the acres in the Watershed Model to achieve the runoff reduction on all pasture acres affected by the BMPs (see the groundtruthing analysis in Section 5.3 for further discussion). Documentation for the sources of cost information do not provide a basis for applying costs to a portion of the acres with BMP-related loadings reductions in the Watershed Model. For Pennsylvania, another key issue is how much the animal waste system and manure export costs overlap impacts of the CAFO rule.

The MHI screening variable looks at impacts on households. However, it is important to recognize that there is no benchmark for such a comparison (i.e., what percent of household income business-related expenses can comprise before imposing substantial financial impacts on the household business). Thus, the potential for substantial impacts may be small even when the MHI screening variable values are above 1% or 2%.

Exhibit 28 summarizes the distribution of MHI screening variable values by tier. The results show that the values are less than 1% in over 66% of counties in Tier 1, approximately 23% of counties in Tier 2, and approximately 15% of counties in Tier 3. Negative values indicate net cost savings, which are primarily due to revenues from state and federal cost-share programs.[10] High values are not evidence of substantial impact; they merely indicate counties that cannot be screened from further impact analysis on the basis of low BMP cost estimates relative to county MHI. A finding of substantial impact would require additional data and analysis regarding the actual financial impacts on farm households or businesses.

Because the MHI values in the denominator are constant across the tiers, the increase in screening variable values reflects increasing mean BMP costs per farm household. Although BMP costs increase substantially across the tiers (from $74 million in private costs in Tier 1 to $133 million in Tier 3), the per-household cost remains below 5% of MHI for over 92% of households in Tier 2 and 65% of households in Tier 3.

[10] Federal and state cost-share programs do not permit funds provided for installation of BMPs to exceed the installation cost. However, net average costs can be negative because certain cost-share programs provide annual maintenance and one-time incentive payments in addition to the installation cost-share (see Appendix E).



Negative values indicate a cost savings compared to the 2000 Progress scenario.

Exhibit 28: Distribution of MHI Screening Values by Tier Scenario

The map in **Exhibit 29** provides a spatial overview of the Tier 1 county-level results for the MHI screening variable. Approximately 12% of counties have values of 2% or higher; these counties tend to be located along the West Virginia-Virginia border, the Virginia shoreline, in Delaware, and in central Pennsylvania. Additional information would need to be collected for these areas to determine if, in fact, substantial impacts are likely. Areas of cost savings compared to the 2000 Progress scenario are evident in coastal Virginia and Maryland. Thus, under Tier 1, most of the jurisdictions in the Bay watershed show little potential for substantial financial impacts. The map of screening variable values for Tier 3 (**Exhibit 30**) shows much higher screening variable values throughout much of the watershed; the map for Tier 2 is in Appendix D. Values are least affected in Maryland, where many counties show net negative Tier 3 costs.

The final screening variable, which indicates counties where widespread economic impacts are unlikely, does not change with the tier scenarios because it is based on an earnings ratio rather than BMP implementation rates. The chart in **Exhibit 31** shows the percentage of jurisdictions, including the independent cities, in each of the value ranges for the screening variable. Four percent of jurisdictions have negative agricultural income and, therefore, have negative values. Earnings in agricultural and related sectors account for less than 5% of total earnings in 85% of watershed jurisdictions.

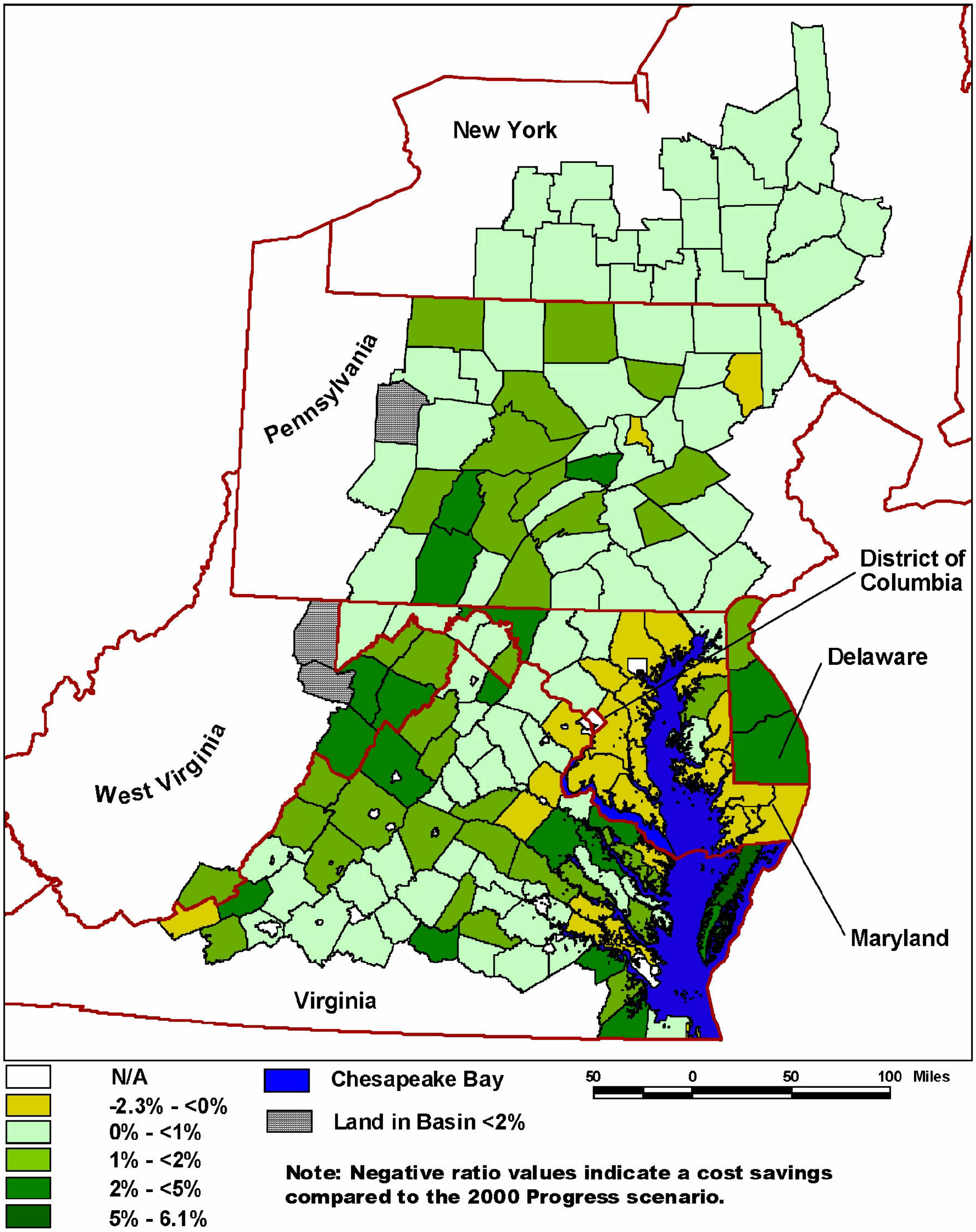


Exhibit 29: Comparison of Average Agricultural BMP Costs to MHI: Tier 1 (Agricultural Sector Screening Variable Values)

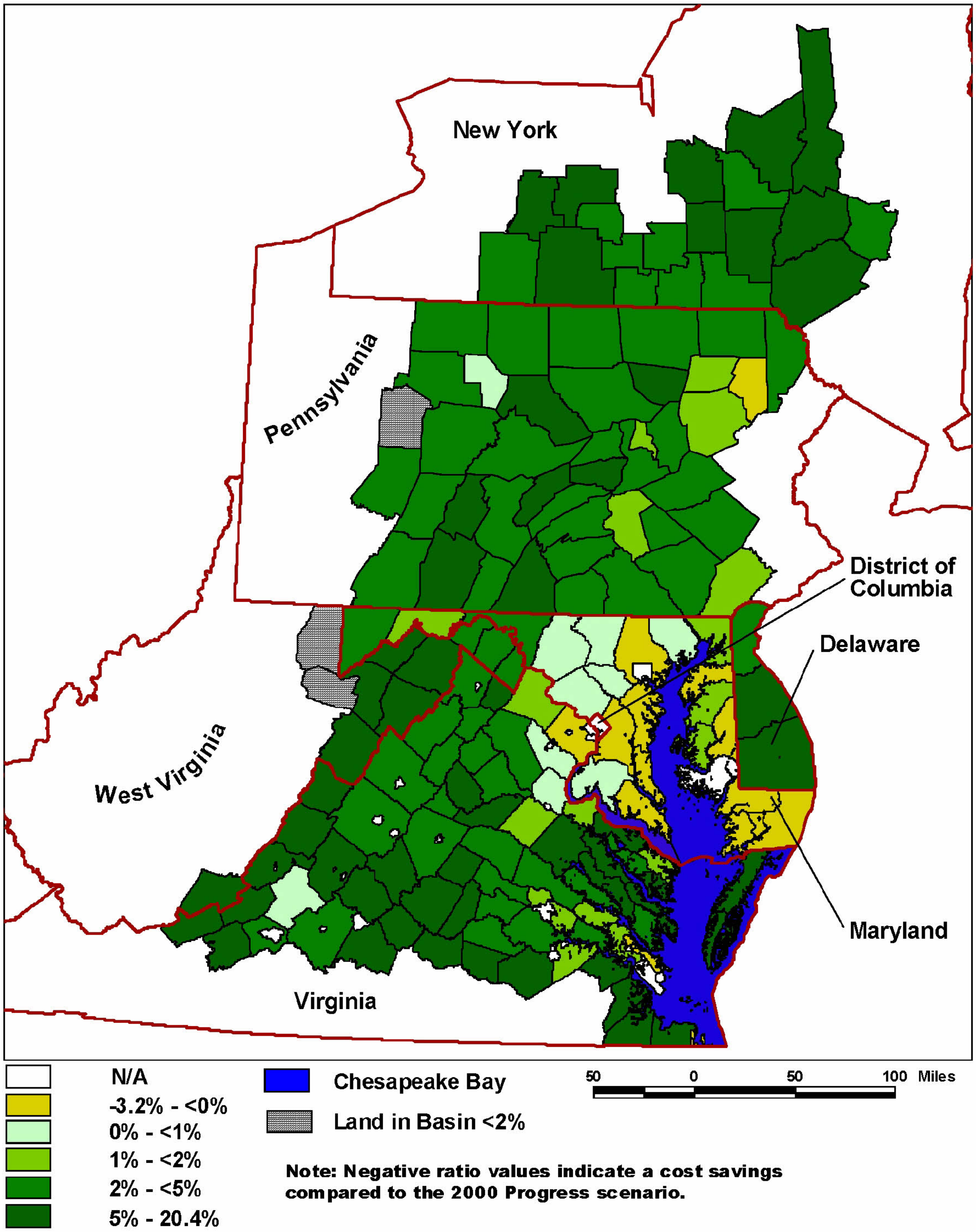
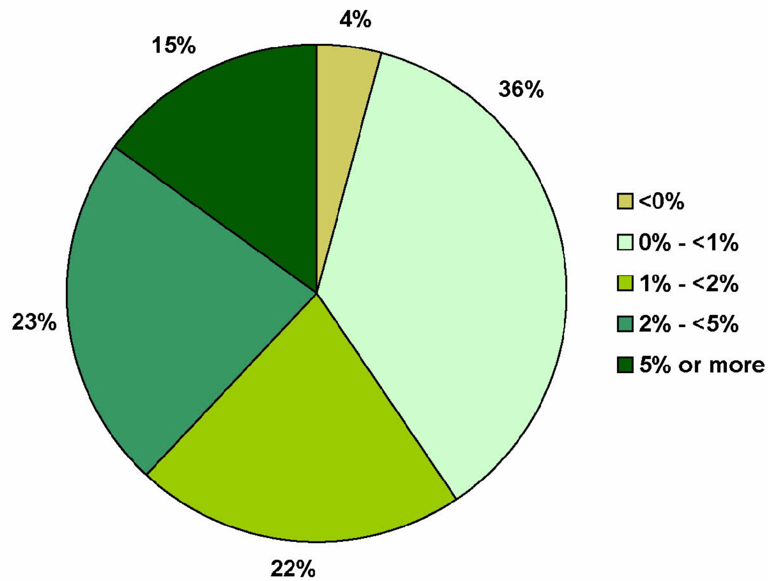


Exhibit 30: Comparison of Average Agricultural BMP Costs to MHI: Tier 3 (Agricultural Sector Screening Variable Values)



Negative values indicate net negative earnings in the agricultural and related sectors.

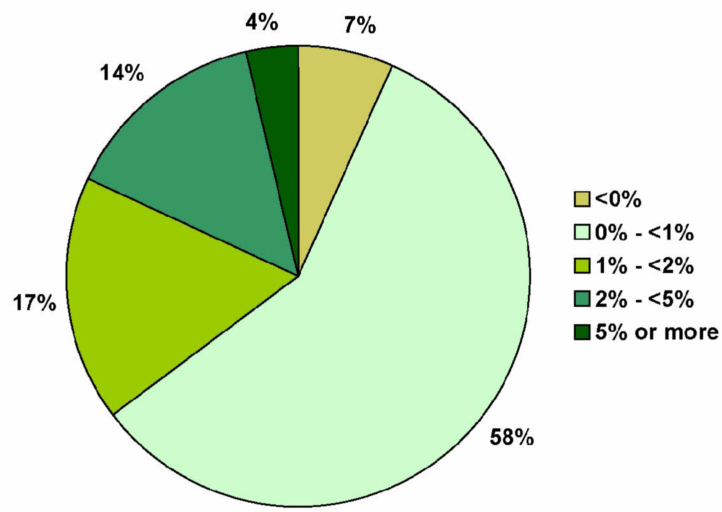
Exhibit 31: Distribution of Agricultural and Related Earnings Screening Variable Values

There is a slight downward bias in several screening variable values in Exhibit 31 because of BEA's nondisclosure policies. In 121 of the 197 Basin jurisdictions, the BEA did not release sector-level earnings data for agricultural services for 1999, which indicates that either there were only 1 or 2 agricultural services providers in the county, or one provider accounted for at least 80% of sector earnings. However, given the generally small percentages of earnings derived from agricultural services (ranging from 0.1% to 0.6% for the basin states), the resulting bias is likely to be small.

Similarly, BEA data on earnings in food and kindred product manufacturing are not disclosed in 75 of the 197 Basin jurisdictions. Again, this indicates that either there were fewer than 3 agricultural services providers in the county or one provider accounted for at least 80% of sector earnings. The proportions of place of work earnings from this sector range from 0% in Washington, D.C. to 1.4% in Delaware and Pennsylvania, so the degree of bias due to nondisclosure is again likely to be small.

The earnings screening variable can overstate the potential for widespread impacts for two reasons. First, the agricultural services sector may actually experience increased income (rather than negative impacts) from BMP implementation. Second, earnings from the food and kindred products sector may not reflect earnings related to crop and livestock production. For instance, Northumberland County, VA has one of the highest values of this indicator (19.6%) because most of the major employers in that county produce and process seafood (J. Gambaccini, Northern Neck Planning District Commission, personal communication, April, 2002). The seafood industry in Northumberland County will not be adversely affected by agricultural BMPs and may, in fact, benefit from improved water quality. The same may be true for other coastal jurisdictions with high indicator values; coastal counties account for half of the counties with screening variable values that exceed 10% and about a quarter of those with values in the 5% to 10% range. Therefore, the screening variable may identify these counties as having widespread impact potential when in fact widespread impacts are unlikely because the related sectors may not be affected by agricultural BMPs or may benefit from water quality improvements.

The potential bias of including the agricultural services and food manufacturing sectors is clear in a comparison of Exhibit 31 with **Exhibit 32**. The share of jurisdictions with earnings from farming only (i.e., without the additional sectors included in the results in Exhibit 31) above 5% declines from 15% to 4%.



Negative values indicate net negative earnings in the agricultural sector.

Exhibit 32: Distribution of Agricultural Earnings Only Screening Variable Values (with Related Sectors Removed)

The agricultural earnings screening variable cannot be interpreted as a demonstration of widespread impact; it merely shows where there is almost no potential for widespread impact given the broad industry classifications and within the limits of BEA data availability. Because the industry classifications are broad and most of the jurisdictions have data reported for agricultural income and at least one of the two other industries, the jurisdictions (Exhibit 31) with less than 5% of reported earnings coming from agriculture and related sectors are unlikely to experience widespread impacts even if there are substantial impacts in the agricultural sector under any tier scenario. In particular, some businesses in the agriculture services industry will most likely benefit from the influx of federal and state funding through cost-share programs. Additional analysis would be needed to demonstrate widespread impacts in the remaining 15% of jurisdictions (Exhibit 31) with earnings shares above 5%. EPA (1995) guidance lists variables for evaluation to determine whether widespread impacts are likely; the screening analysis serves only to focus such an effort.

The map in **Exhibit 33** shows the spatial distribution of the widespread indicator values throughout the watershed. The noncoastal jurisdictions with higher indicator values (e.g., greater than 5%) are predominantly located in east-central Pennsylvania and along the West Virginia-Virginia state boundary.

Having screening indicators for both substantial and widespread impacts for agriculture provides an opportunity to evaluate when potential exists for both conditions. The scatter plot in **Exhibit 34** shows the combined results for the MHI screening variable (Tier 1) and the widespread screening variable for each jurisdiction. Most of the data points are close to the one of the axes, indicating low potential for either type of impact. The MHI variable values that exceed 1% are generally associated with widespread variables below 5%. Similarly, the high widespread screening variable values tend to be associated with MHI variable values that are less than 1%. Thus, under Tier 1, there is little evidence of potential for substantial *and* widespread impacts.

The scatter plots in **Exhibits 35** and **36** show outcomes for the Tier 2 and Tier 3 MHI screening variables, respectively, and widespread screening variables. While more points have a MHI variable value above 1% in Tiers 2 and 3, many of these points have widespread variable values of less than 5%. Thus, although the potential for substantial impacts is higher under Tiers 2 and 3, many jurisdictions are still unlikely to experience both substantial and widespread impacts.

The plots in Exhibits 35 and 36 use the original widespread screening variable, which includes earnings in agricultural related sectors. A variable based solely on agricultural income would have substantially fewer scatter points with high widespread variable values. **Exhibit 37** illustrates the impact using the MHI screening variable values for Tier 3 and the recalculated widespread screening variable. Comparing the two Tier 3 charts shows that most of the scatter points to the right of 5% along the widespread screening variable axis in Exhibit 36 are no longer present in Exhibit 37.

Exhibit 38 lists the counties that have initial widespread screening variable values greater than 5% and MHI values greater than 1%. It also shows that all but 6 of the widespread variable values fall below 5% when the related industries are excluded from the widespread screening variable. The counties with values that continue to exceed 5% are primarily located along the Virginia-West Virginia border and southwest of Richmond, VA.

As noted in Section 5.2, the values for the screening variable can be biased for several reasons (see **Exhibit 39**). For example, the MHI values reflect the assumption that the ratio of BMP costs to MHI in 2010 would be the same as it is in 2001. If household incomes increase more rapidly than BMP costs, then the values are overestimated. Furthermore, all of the variables incorporate current cost share percentages for some BMPs. Changes in the cost share assumptions would alter the values of the screening variables. Lower cost share amounts would increase private costs and variable values, and higher shares would decrease private costs and variable values. Third, BMP costs use constant average unit costs although costs may differ by location. Finally, the screening variable uses county MHI, which may differ from farm household incomes. The USDA reports that, on average, farm households have higher incomes and greater wealth than all U.S. households (USDA, 2002).

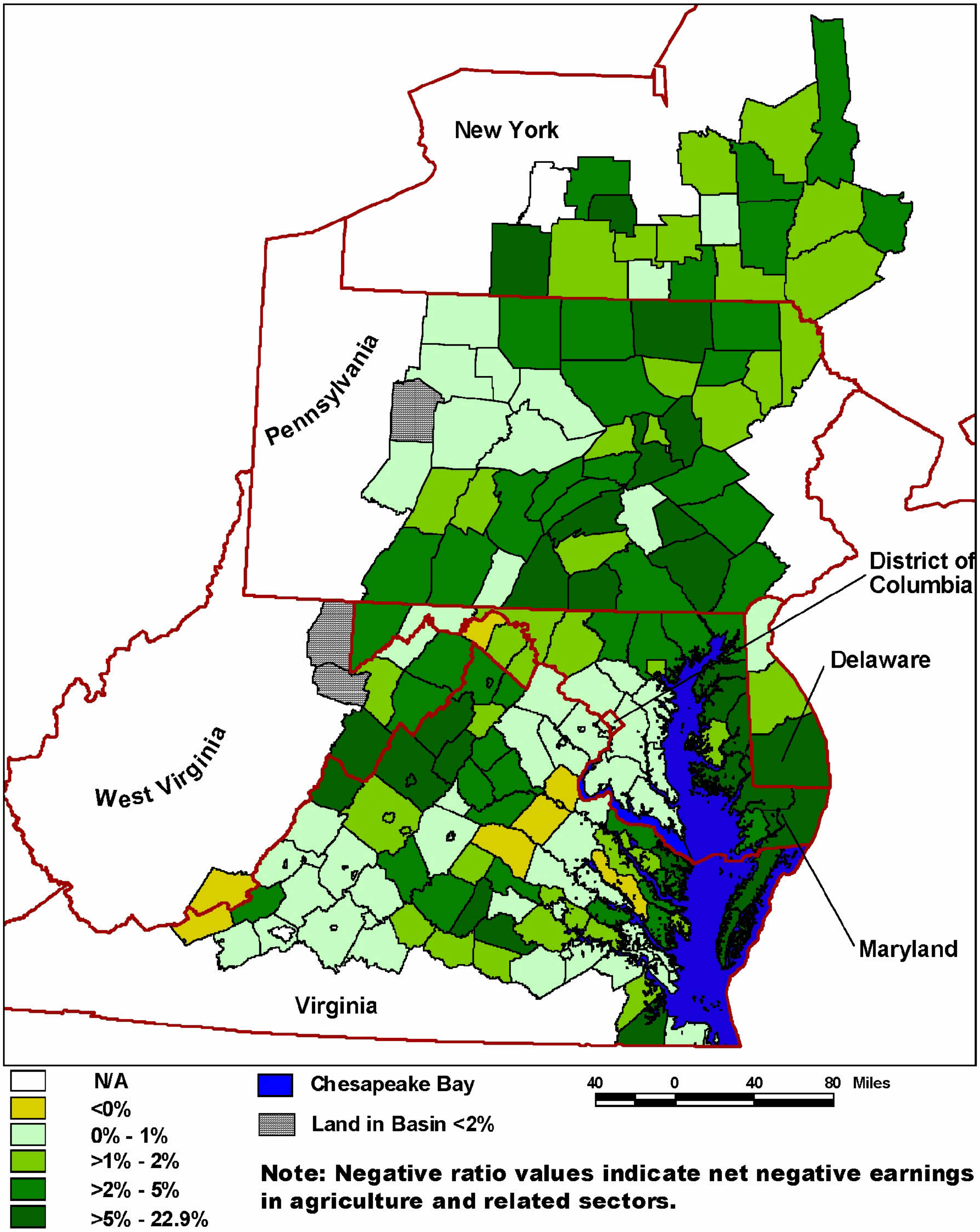


Exhibit 33: Comparison of Agricultural and Related Earnings to Total Earnings (Agricultural Sector Screening Variable Values)

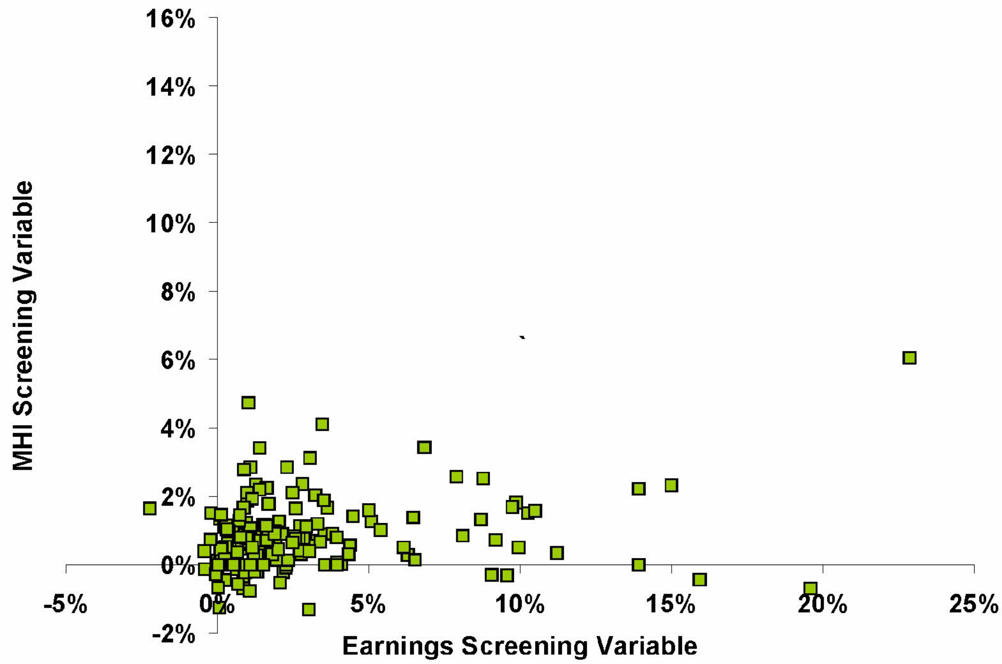


Exhibit 34: Joint Earnings and MHI Screening Variable Values (Tier 1)

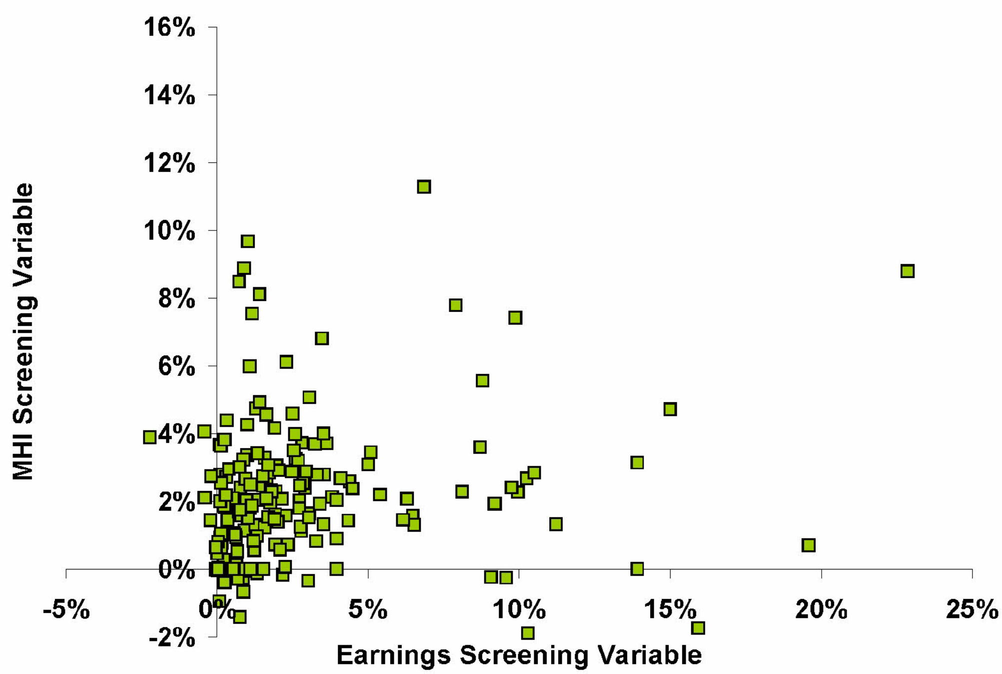


Exhibit 35: Joint Earnings and MHI Screening Variable Values (Tier 2)

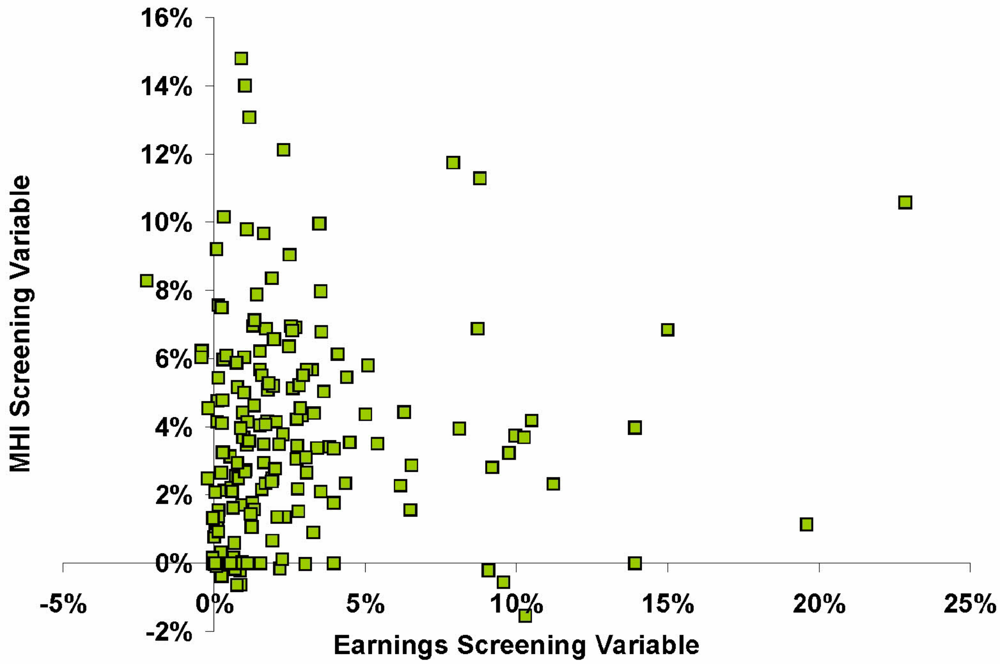


Exhibit 36: Joint Earnings and MHI Screening Variable Values (Tier 3)

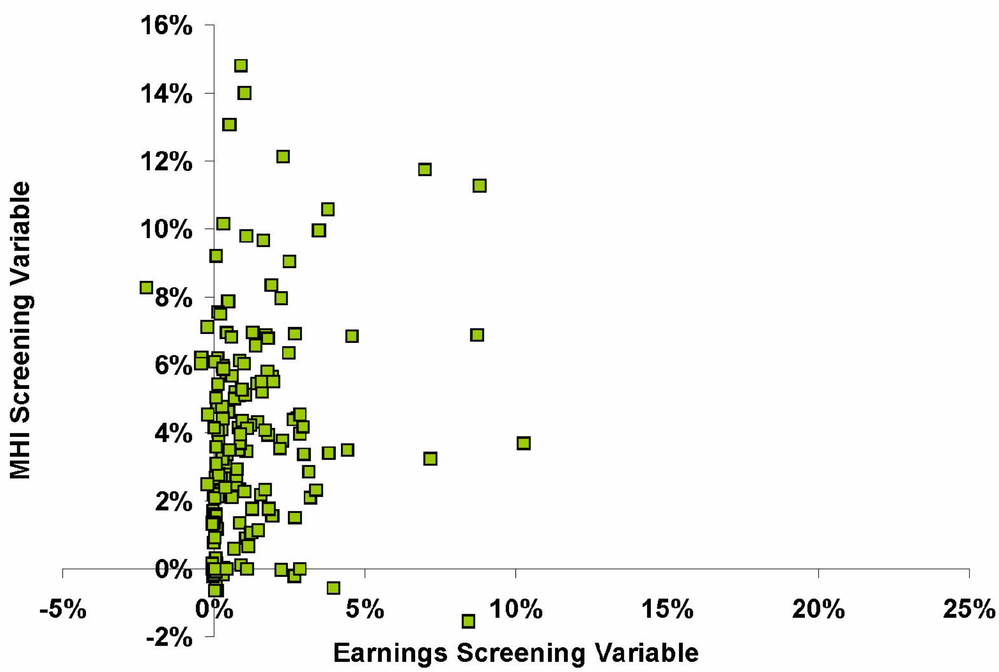


Exhibit 37: Joint Earnings and MHI Screening Variable Values with Related Sectors Removed (Tier 3)

Exhibit 38: Jurisdictions with Earnings Screening Variable Values Greater than 5% and MHI Values Greater than 1%

Jurisdiction	Earnings Screening Variable (including related industries)	Earnings Screening Variable (farm income only)	MHI Screening Variable[1]
Lebanon, PA	5.0%	0.9%	4.4%
Franklin, PA	5.1%	1.8%	5.8%
Perry, PA	5.4%	4.4%	3.5%
Lancaster, PA	6.2%	1.0%	2.3%
Allegany, NY	6.3%	2.8%	4.4%
Queen Annes, MD	6.5%	1.9%	1.6%
Yates, NY	6.5%	3.1%	2.9%
Suffolk, VA	6.8%	0.7%	19.3%
Northampton, VA	7.9%	7.0%	11.7%
Bradford, PA	8.1%	1.8%	3.9%
Cumberland, VA	8.7%	8.7%	6.9%
Pendleton, WV	8.8%	8.8%	11.3%
Columbia, PA	9.2%	0.2%	2.8%
Page, VA	9.7%	7.2%	3.2%
Highland, VA	9.9%	9.9%	17.1%
Northumberland, PA	10.0%	0.2%	3.7%
Amelia, VA	10.3%	10.3%	3.7%
Shenandoah, VA	10.5%	3.0%	4.2%
Adams, PA	11.2%	3.4%	2.3%
Rockingham, VA	13.9%	2.9%	4.0%
Sussex, DE	15.0%	4.6%	6.9%
Northumberland, VA	19.6%	1.5%	1.1%
Accomack, VA	22.9%	3.8%	10.6%

1. The 1% breakpoint used to compile data for this table should not be interpreted as a threshold for analysis for the MHI screening variable. This variable differs from the MPS screening variable used for the POTW analysis, where the 1% threshold comes from EPA (1995) guidance. There are no guidance thresholds for the MHI variable and jurisdictions with values above 1% may not incur substantial impacts.

Exhibit 39: Sources of Uncertainty in Screening Variables for the Agriculture Sector

Source	Direction of Bias	Comments
Values to not reflect any real growth in MHI or agricultural sales and income.	+	Cost-to-income ratios may be overestimated.
Current BMP cost shares are used to estimate farmer costs.	+	Under the 2002 Farm Bill, cost shares may be higher, which would reduce farmer costs.
Average unit BMP costs are applied to all BMP acres throughout the watershed.	?	Actual BMP costs will vary from site to site.
MHI is for county rather than farm household.	?	Nationally, farm household MHI is slightly greater than overall MHI (USDA, 2002), but this may vary from county to county.
BEA earnings data for agriculture-related sectors is not reported for some counties.	–	Some variable values are slightly lower than they would be had BEA earnings data been complete.
Net cash return and sales data are prorated based on percentage of agricultural land in watershed.	?	Prorating data implies a uniform distribution of sales and net returns over agricultural land; county portions within the watershed may have higher or lower average sales and net returns.
Net cash return plus government payments does not account for depreciation, inventory changes, or noncash benefits (e.g., consumption of farm products).	?	Profit would equal net cash return minus depreciation and net inventory change; depreciation and inventory change are not available from the Census of Agriculture.
Net cash return in 1997 is relatively low for most counties for the period 1996-2000.	+[1]	Impacts on profits should be determined based on three consecutive years so that one bad (or good) year does not generate a false positive (or negative) result (U.S. EPA, 1995).

+ = assumption results in overestimating potential for impacts
– = assumption results in underestimating potential for impacts
? = impact of assumption on indicator values is unknown
1. Potential impact on indicators is positive for most counties and may be zero or negative for others; see comment.

Regarding the cost share assumptions, there is great uncertainty in the extent of costs that will actually be borne by farmers. The 2002 Farm Bill increases federal overall conservation funding by 80% above the level committed by the last (1996) farm bill. In addition, the new law permits a greater percentage of BMP installation costs (90%, up from 75% in the 1996 bill) to be granted to limited-resource farmers under the Environmental Quality Incentives Program. Therefore, costs paid by farmers may be lower than those used in the screening analysis, and impacts may be overstated. As one example, although specific provisions for the yield reserve BMP in the tier scenarios are not included in the bill, the program may be funded under an innovative technologies clause of the bill (personal communication with T. Simpson, Chair, CBP Nutrient Subcommittee, May 2002). If implemented, this cost-share program could result in annual incentive payments of $20 to $40 per acre that are not included in the screening analysis. Funding for this program alone would reduce the agricultural costs borne by farmers in Tier 3 by $17 million to $42 million per year.

Also, due to the large number of programs and sources across states, the cost-share information may be incomplete. The cost-share assumptions in the impact analysis are very complex because they vary by state, program, and BMP (see Part I). Cost shares may include a variety of contract arrangements including a capital cost share, an annual rental payment, an up-front incentive payment, and an annual maintenance cost. For this analysis, the CBP did not factor in the substantial annual rental payments but instead assumed that they would offset any revenue losses resulting from BMP implementation. If instead, rental payments more than offset any losses (e.g., BMPs are implemented on marginal land such that little revenue is lost), the screening analysis may overstate impacts.

5.3 Groundtruthing of Screening Results

To further evaluate how well the screening variables reflect the likelihood of substantial and widespread impacts, this section provides more comprehensive analysis of the results for Allegany County, MD. **Exhibit 40** contains a summary of the estimated costs and screening variable values across the modeling scenarios.

Exhibit 40: Agricultural Costs and Screening Variable Values for Allegany County, MD (2001$)

Estimate	Tier 1	Tier 2	Tier 3
Private Agricultural Costs	83,109	108,304	163,273
State and Federal Agricultural Costs[1]	287,560	488,090	795,238
Till crop plus portion of hay costs as percent of crop and hay sales	0.1%	–1.0%[2]	–2.3%[2]
Livestock plus portion of hay costs as percent of livestock and product sales	3.7%	5.3%	8.5%
Agricultural BMP costs per farm as percent of county MHI	0.9%	1.1%	1.7%
Agriculture and related sector earnings as percent of total earnings by place of work	0.9%	0.9%	0.9%

1. Assumes that all needed BMPs are cost shared at current rates.
2. Costs are negative (i.e., net income to the farmer increases because of cost-share program funding).

As noted above, some indicator variables in the screening analysis are conservative and, as such, may overestimate potential for impacts.

5.3.1 Crop Sales Screening Variable

The screening analysis indicates that estimated costs for BMPs on cropland represent less than half a percent of the value of crop sales under Tiers 1 and 2, and net revenue increases under Tier 3. **Exhibit 41** provides a summary of the BMP costs and sales data used to calculate the Tier 3 ratio. The negative value for the till crop screening variable under Tiers 2 and 3 results from a combination of reductions in some BMPs compared to the 2000 Progress scenario (e.g., conservation tillage, nutrient management plan, and farm plans) and net earnings from cost-share program incentive and annual maintenance payments that exceed BMP costs (e.g., forest and grass buffers and land retirement). Thus, BMP-related revenues could actually improve crop-related financial ratios and, therefore, do not currently indicate a substantial negative impact.

Exhibit 41: Summary of Crop and Livestock BMP Costs and Sales for Allegany County, MD

Item	Cropland[1]	Livestock[2]
BMP Costs for Tier 3 (2001 dollars)[3]	($27,101)	$190,374
Market Sales (1997 dollars)	$1,150,000	$2,172,000
Market Sales (2001 dollars)	$1,185,385	$2,238,831
Ratio of BMP Costs to Sales	-2.3	8.5

1. BMPs include forest buffers, grass buffers, conservation tillage, wetlands restoration, erodible land retirement, carbon sequestration, nutrient management, yield reserve, farm plans, and cover crops.
2. BMPs include forest buffers, wetlands restoration, farm plans, stream protection, and grazing land protection. (There are no costs for livestock BMPs, animal waste management systems and excess manure hauling, because the Watershed Model does not apply these BMPs in Allegany County under any tier scenario.)
3. The cost of BMPs for hay land is split between crops and livestock based on the shares of crop and livestock sales in the county. In Allegany County, sales of livestock and livestock products accounts for about 65% of total sales and hay BMP costs are $4,220. Thus, livestock BMP costs include $187,615 for pasture BMPs plus $2,759 in hay costs (about 65% of total hay BMP costs); cropland BMP costs include negative $28,562 for cropland BMPs plus the remaining hay BMP costs of $1,461 ($4,220–$2,759).

5.3.2 Livestock Sales Screening Variable

The preliminary economic framework indicates that potential costs for livestock-related BMPs represent 3.7% to 8.5% of sales from livestock and livestock products in the county. Exhibit 41 shows the BMP costs and sales data used to calculate the ratio for Tier 3. Because profit data are not available at the sector level, it is unknown whether the livestock subsector is initially profitable.

Livestock BMP costs include $136,508 for streambank protection on 3,620 acres (with or without fencing) and $53,705 for grazing land protection on 5,376 acres; there are no animal waste BMPs (i.e., animal waste management systems or excess manure hauling) required under Tier 3. The degree of pasture land BMP implementation may be excessive given the number of animals in the county that are typically pastured, and their distribution by farm size category. Detailed information from the 1997 Census of Agriculture in **Exhibit 42** indicates that most farms with either cattle or sheep have fewer than 100 animals. Thus, this source indicates that the livestock industry is not concentrated at a few large farms with high intensity grazing. Furthermore, a comparison of the total number of animals in Exhibit 42 with the amount of grazing land being protected in Tier 3 suggests the possibility that either grazing intensity is generally very low, which implies that the unit BMP cost per acre overstates likely costs for this county, or that intense grazing occurs on relatively few acres, which implies that BMP acres are overstated. Because livestock BMP costs are driving the MHI screening variable value in Exhibit 38, any question regarding the accuracy of these costs extends to this indicator as well.

Exhibit 42: Livestock Distribution in Allegany County, MD

Category	Total Animals in 1997	Number of Farms with Animals (total animals)					
		1–9 Animals	10–19 Animals	20–49 Animals	50–99 Animals	100–199 Animals	200–499 Animals
Cattle & calves inventory	5,341	34 (191)	43 (D)	35 (1,076)	27 (1,839)	12 (1,442)	1 (D)
Sheep & lambs inventory[1]	241	8 (114)		3 (127)		0 (0)	0 (0)

Source: 1997 Census of Agriculture.
D = Withheld to prevent disclosing data for individual farms.
1. The size thresholds for sheep differ slightly; the smallest size category is 1–24 animals and the next smallest is 25–99 animals.

5.3.3 MHI Screening Variable

The screening analysis indicates that total potential per farm BMP costs represent between 0.9% and 1.7% of MHI in the county. Data on large and corporate farms in Allegany County indicates that most farms are both small and operated by families, individuals, or partnerships rather than corporations. The 1997 Census of Agriculture reported that only one of the 239 farms in Allegany County met the USDA definition of "large" (i.e., over $250,000 in sales), and only 3 were corporation owned (all by family corporations). Because 99.6% of the farms in the county are small farms and 98.8% are not corporate, this variable is more relevant to farm financial conditions and, therefore, is a useful indicator of whether farms in Allegany County would not experience substantial financial impacts.

Based on the screening analysis results, it appears that there is little potential for substantial impacts. Total BMP costs are small relative to household incomes, and the crop sector potentially has net cost savings. Although the livestock variable is higher, the pasture BMP costs appear to be overstated for the number of animals in the county.

6. Screening Analysis for Urban Sources

Controls for urban sources in the Watershed Model include riparian forest buffers, environmental site design, storm water retrofits, storm water management on new and recent development, urban nutrient management, urban growth reduction, and forest conservation. These practices apply to pervious and impervious urban land, as well as mixed open land, which represents herbaceous land not classified as agricultural, forest, or urban (such as parks and golf courses). Urban controls are likely to be implemented by municipal governments, which will pass on costs to households in the form of taxes and fees.

6.1 Screening Variables

A screening variable for substantial impacts can be constructed to represent the MPS due to urban source controls at the county level:

- Urban BMP costs per urban household as a percent of county MHI

and may reflect a conservative or high per-household cost if controls on mixed open land (e.g., parks, golf courses) are implemented and paid for at the county level and, therefore, spread over a larger population base.

The number of urban households is based on urban population data from the 2000 Census of Population and Housing (U.S. Census Bureau, 2002). In the 2000 Census, urban areas include incorporated cities, towns, and villages and unincorporated Census-designated places with 2,500 or more people, plus "urbanized areas" and "urban clusters" (i.e., fringes of urbanized areas). For each county, urban households in the watershed in 2010 is based on the 2000 Census data on urban population, the proportion of the county population within the watershed, population projections to 2010 using a methodology developed by the CBP, and the number of people per household from the 2000 Census (see Appendix B). The implicit assumptions in this method are:

- The proportion of urban population in the watershed is equal to the proportion of total population in the watershed

- Urban population growth from 2000 to 2010 is equal to overall population growth within the watershed.

MHI at the county level is from the 2000 Census of Population and Housing (U.S. Census Bureau, 2002), adjusted to 2001 dollars using the CPI (BLS, 2002).

6.2 Screening Results

Exhibit 43 provides a summary of the urban screening variable values by tier scenario. In Tier 1, only 1% of jurisdictions incur costs that exceed 1% of MHI, indicating that 99% of jurisdictions are not likely to experience substantial impacts due to urban BMPs. In Tier 2, screening variable values are slightly higher in a few jurisdictions, but almost 95% still have values below 1%. In Tier 3, about 79% of jurisdictions have screening variable values in the 0% to 1% range; another 13% have values in the 1% to 2% range. The remaining 8% have variable values above 2%. The screening variable values can show where substantial impacts are unlikely to occur, but they cannot be used to demonstrate substantial impacts. Analyses similar to the secondary test for POTWs would be needed to show substantial impacts. Furthermore, a widespread test is also required to show socioeconomic impacts such as reduced personal income and increased unemployment.

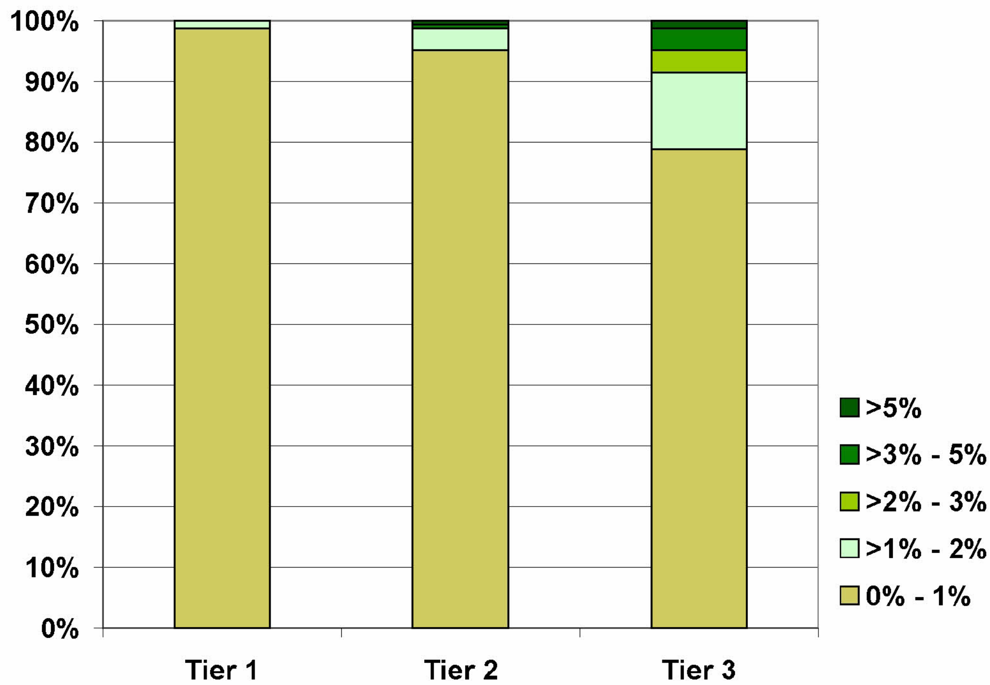


Exhibit 43: Distribution of Urban Screening Variable Values by Tier Scenario

The Tier 3 results reflect the impact of high storm water retrofit costs (approximately $377 million per year). Because the retrofit costs account for almost 89% of annual costs, the screening variable values are highly dependent on those costs. Consequently, it is important to consider a few sources of upward bias in these estimates. First, the retrofit costs used in the screening analysis are high compared to other regional estimates. Thus, the screening analysis generates a high estimate of the number of jurisdictions potentially triggering a secondary test. Second, the retrofit costs do not include any federal or state cost share funding and they do not reflect "piggy back" opportunities that would reduce implementation costs. These factors contribute to the likelihood that costs and screening variable values are overstated. Finally, many of the counties with high screening variable values tend to have small urban populations in the Bay watershed compared to the number of urban retrofit acres (**Exhibit 44**). This raises a question about either the accuracy of assuming constant average unit control costs for all acres or the method used to allocate population among urban and nonurban categories. Furthermore, 32 counties have zero urban population according to the 2000 Census and, therefore, have no urban population estimates in 2010 (Exhibit 44). Nevertheless, the watershed model indicates urban BMPs would be applied. Exhibit 43 excludes these counties because the screening variable value cannot be calculated.

Exhibit 44: Counties With Low or Zero Urban Households (2001$)

County	2010 Urban Households	Urban BMP Costs[1]	Mixed Open BMP Costs[1]	Urban and Mixed Open BMP Costs per Urban Household
Garrett, MD	353	$123,815	$4,745	$364
Fulton, PA	0	$112,299	$8,711	n/a
Jefferson, PA	0	$22,984	$247	n/a
McKean, PA	7	$3,353	$445	$543
Potter, PA	0	$64,091	$39,015	n/a
Sullivan, PA	0	$81,671	$37,765	n/a
Amelia, VA	0	$104,888	$13,155	n/a
Appomattox, VA	0	$192,873	$5,657	n/a
Bath, VA	0	$150,116	$5,103	n/a
Buckingham, VA	0	$214,330	$17,435	n/a
Caroline, VA	0	$336,518	$15,767	n/a
Charles City, VA	0	$37,715	$4,205	n/a
Craig, VA	0	$26,434	$2,223	n/a
Cumberland, VA	125	$120,646	$10,735	$1,051
Goochland, VA	384	$425,780	$13,010	$1,143
Greene, VA	0	$205,180	$6,043	n/a
Highland, VA	0	$47,836	$8,486	n/a
King and Queen, VA	0	$54,701	$7,092	n/a
King George, VA	0	$330,038	$6,111	n/a
Lancaster, VA	0	$115,533	$5,337	n/a
Louisa, VA	0	$318,911	$17,426	n/a
Madison, VA	0	$482,391	$6,928	n/a
Mathews, VA	0	$96,519	$5,557	n/a
Middlesex, VA	0	$90,929	$5,341	n/a
Nelson, VA	0	$242,694	$10,319	n/a
New Kent, VA	0	$251,407	$5,421	n/a
Northampton, VA	0	$114,348	$4,523	n/a
Northumberland, VA	0	$125,719	$7,035	n/a
Rappahannock, VA	0	$232,370	$6,571	n/a
Rockbridge, VA	291	$615,282	$12,085	$2,156
Surry, VA	0	$99,517	$4,014	n/a
Hampshire, WV	0	$291,341	$7,850	n/a
Hardy, WV	0	$199,913	$5,820	n/a
Morgan, WV	0	$164,703	$5,636	n/a
Pendleton, WV	0	$132,863	$6,697	n/a

n/a = result is undefined.

1. Estimated based on acres of urban BMPs in the Watershed Model and the unit cost (in $/acre) for each BMP (see Part I).

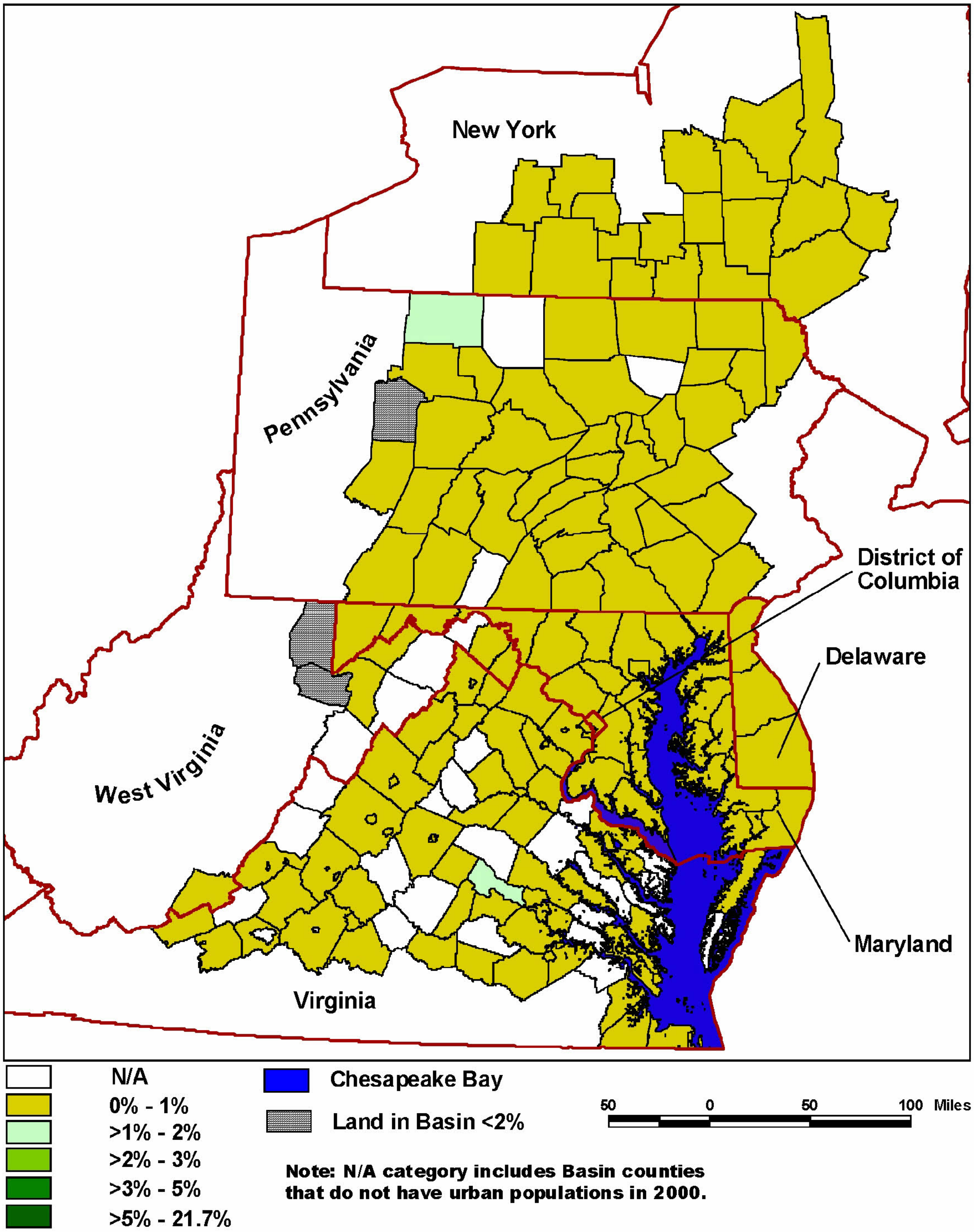


Exhibit 45: Comparison of Average Household Urban BMP Costs to MHI: Tier 1 (Urban Screening Variable Values)

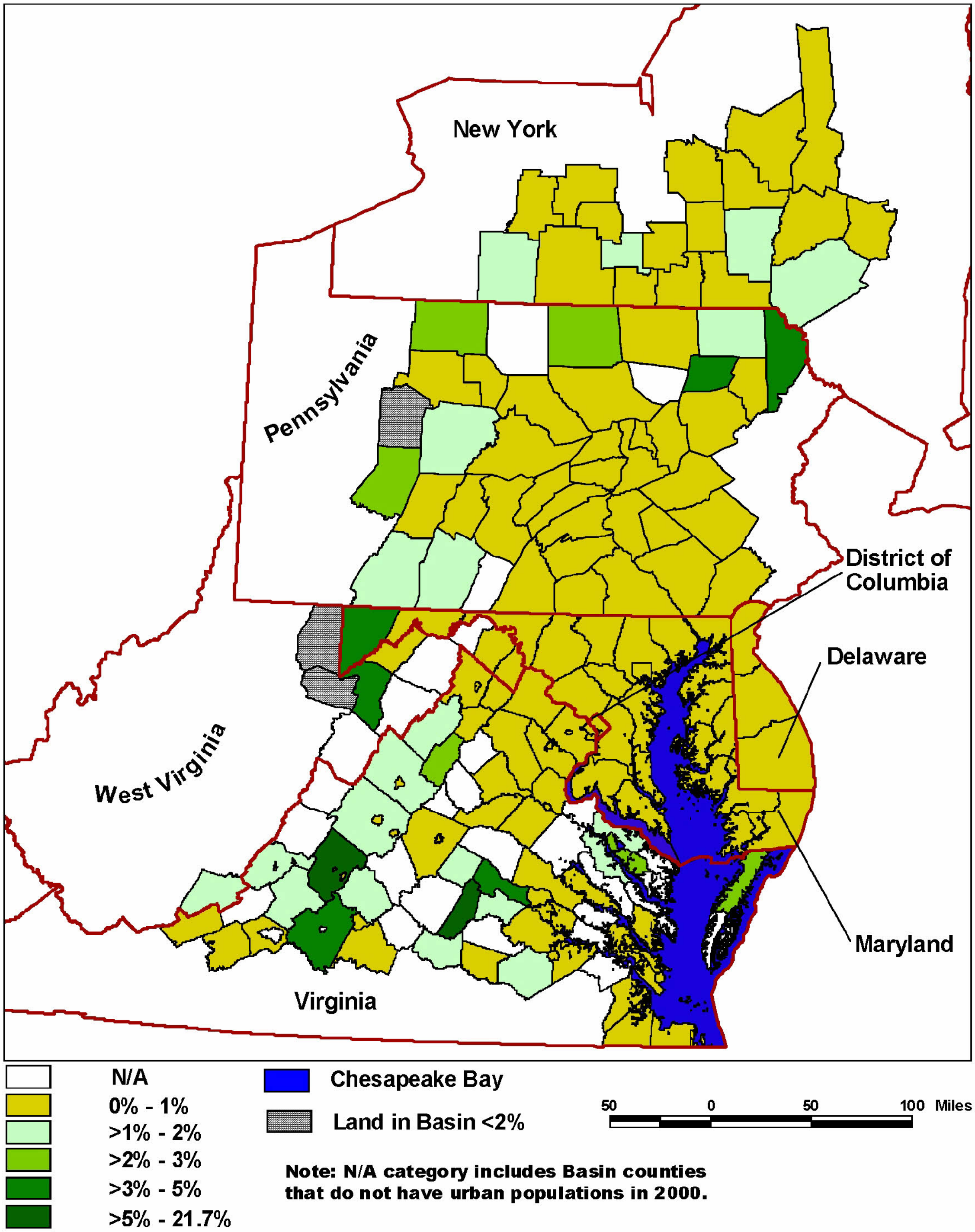


Exhibit 46: Comparison of Average Household Urban BMP Costs to MHI: Tier 3 (Urban Screening Variable Values)

Additional sources of uncertainty include the assumption that urban MHI estimates are comparable to county MHI estimates, and assumptions made to derive urban population estimates from Census and Chesapeake Bay Program data. These assumptions include that urban population growth rates equal overall county population growth rates, and that populations are evenly spread out in counties that are partially in the watershed (e.g., if 45% of county population is in the watershed, then 45% of the urban population is in the watershed). Finally, there is no attempt to incorporate real growth in MHI because projections are not available. If urban incomes rise more rapidly than prices in general between 2001 and 2010, then the values of the screening variable are overestimated, and vice versa.

The spatial distribution of screening variable values for Tier 1 (**Exhibit 45**) shows that the two counties with values above 1% are Goochland, Virginia (1.05%), and McKean, Pennsylvania (1.01%). Both values are very close to 1% and may indicate that substantial impacts are unlikely. Also note that both counties are listed in Exhibit 44 as having relatively low urban populations, particularly compared to Tier 3 BMP implementation, which raises a question about whether the BMP cost estimates have an upward bias. For Tier 3 (**Exhibit 46**), counties with higher screening variable values tend to be located in inland areas where population density tends to be lower. Counties that do not have urban populations appear white on the maps because the indicator is not applicable to those counties.

6.3 Groundtruthing of Screening Results

To continue to investigate how well the urban screening variable functions to focus the analysis away from areas not likely to experience substantial and widespread impacts, this section provides more comprehensive analysis of the results for Allegany County, MD.

Exhibit 47 provides a summary of the estimated costs and urban screening variable across the modeling scenarios. Costs for urban areas range from $0.3 million under Tier 1 to $2.6 million under Tier 3, with the higher Tier 3 costs reflecting the more costly retrofitting of urban areas with storm water controls. The screening variable value incorporates an estimate of 19,386 urban households in Allegany County in 2010. Nonetheless, household costs for BMPs on urban and mixed open land represent less than half a percent of household income in Allegany County under all tiers, indicating that substantial and widespread impacts from urban source controls are not likely.

Exhibit 47: Urban Screening Data for Allegany County, MD (2001$)

Estimate	Tier 1	Tier 2	Tier 3
Urban and Mixed Open Costs	$334,503	$854,364	$2,572,116
Urban BMP costs per household as percent of county MHI	0.0%	0.1%	0.3%

7. Screening Analysis for Onsite Wastewater Management Systems

The BMP in the Watershed Model for onsite wastewater management systems (OSWMSs) is denitrification plus more frequent pumping. The tier scenarios specify this control as an upgrade for a very small percent of existing systems, and as the selected technology for all new OSWMSs anticipated in the watershed by 2010. OSWMSs are most common in rural areas, but households designated as urban by the Census also have OSWMSs. For instance, many of the "independent cities" of Virginia, cities that also function as counties, contained households served by septic systems or cesspools according to the 1990 Census (U.S. Census Bureau, 1993).

7.1 Screening Variables

A screening variable can be constructed similar to the MPS for households using onsite waste management systems:

- Average per household BMP cost as a percent of county MHI.

Few households (i.e., less than 1% of existing onsite systems under Tier 3) are expected to incur increased costs as a result of onsite system BMPs. Therefore, even if impacts were found to be substantial, they not likely be widespread. Thus, another screening variable can be constructed to represent the share of households affected:

- Number of households in the county implementing septic system BMPs in 2010 divided by 2010 households in the portion of the county within the watershed.

The number of households in the county within the watershed in 2010 is based on the Chesapeake Bay Program's data on 2000 population, data from the 2000 Census on population per household (U.S. Census Bureau, 2002), and the Chesapeake Bay Program's 2010 population projections (see Appendix B).

7.2 Screening Results

Tier 3 is the only control scenario that includes the onsite system BMP for existing systems. For this scenario, 23% of counties have MHI screening variable values below 2%; 61% have indicator values in the 2% to 3% range; and 16% have variable values in the 3% to 4% range. These results reflect no funding to offset costs.

The widespread screening variable is based on the share of households affected by this BMP. All counties fall in the 0% to 1% range for this variable; the maximum value is 0.8% (Mathews, Virginia). Thus, it is unlikely that any jurisdiction would experience substantial and widespread impacts based on this BMP. **Exhibit 48** demonstrates this result using combined substantial and widespread screening variable data for Tier 3.

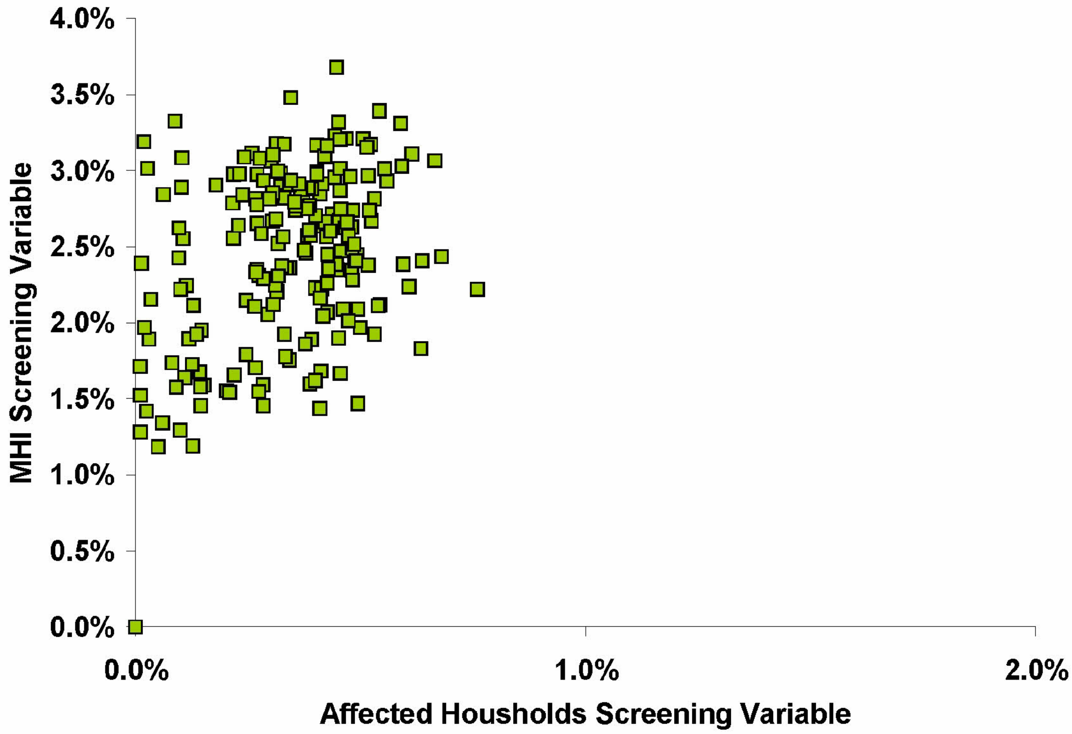


Exhibit 48: Joint Screening Variable Values for Onsite Waste Management Systems

Exhibit 49 contains a map showing the Tier 3 MHI screening variable values. Although the joint variable analysis shows that no jurisdiction is likely to have substantial and widespread impacts, this map is informative because it shows the distribution of household incomes throughout the watershed. That is, the BMP cost per household is the same in all areas, so the changes in the variable value reflect the level of MHI. Household incomes tend to be highest (greater than $57,000) in the counties surrounding Washington, D.C. Counties in the next ring (i.e., having variable values in the 2% to 3% range) have incomes ranging from $38,000 to $57,000. Washington, D.C., itself, is in this second income bracket. Incomes in the remainder of the watershed are generally below $38,000.

Sources of uncertainty for the MHI screening variable overlap with some sources of uncertainty for other screening variables. **Exhibit 50** summarizes these factors.

7.3 Groundtruthing of Screening Results

To further investigate how well the onsite system screening variables reflect the likelihood of substantial and widespread impacts, this section provides more comprehensive analysis of the results for Allegany County, MD. **Exhibit 51** provides a summary of the estimated costs and screening variables for onsite systems across the modeling scenarios. Because so few existing systems will implement this control, substantial and widespread impacts are unlikely in Allegany County.

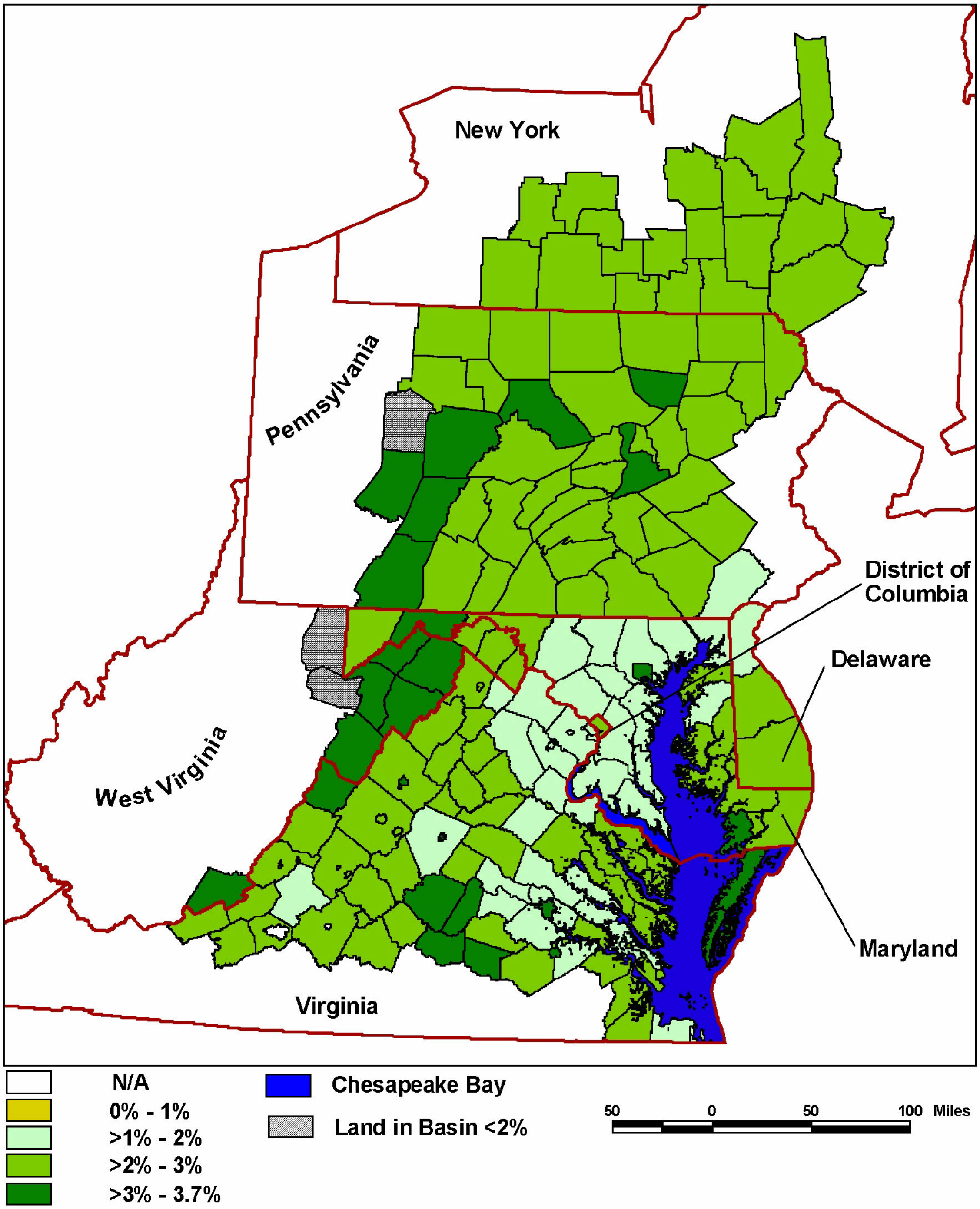


Exhibit 49: Comparison of Onsite System Costs to MHI: Tier 3 (Onsite System Screening Variable Values)

Exhibit 50: Sources of Uncertainty in the Screening Variables for Onsite Systems

Source	Direction of Bias	Comments
No real income growth through 2010.	+	Actual MPS values will be lower in areas for which real person income is forecast to grow by 2010, and lower in areas where real income is forecast to decline by 2010.
Constant unit BMP costs for all onsite systems.	?	Actual BMP costs will vary from site to site.

+ = assumption results in overestimating screening variable values
? = impact of assumption on screening variable values is unknown.

Exhibit 51: Onsite System Screening Data for Allegany County, MD (2001$)

Estimate	Tier 1	Tier 2	Tier 3
Onsite System BMP Costs	0	0	80,507
Onsite system costs per household implementing onsite system BMPs as percent of county MHI	0.0%	0.0%	3.1%
Percent of households incurring onsite system BMP costs	0.0%	0.0%	0.3%

8. POTW and Urban Sectors Combined

Some households may experience impacts from controls on more than one sector. For instance, urban households may see increasing costs due to both urban area controls and POTW controls. Farm households may also experience impacts from both agricultural BMPs and onsite system BMPs. However, onsite system BMPs only occur in the Tier 3 scenario, and affect only 1% of all (farm and nonfarm) existing systems (representing failed systems and opportunities for upgrades). Therefore, the extent of this combination of controls is very limited (because it applies to 1% of existing systems, which may be less than 1% of farm households in a jurisdiction because some nonfarm households will likely be affected).

8.1 Screening Variables

A screening variable can be constructed for combined POTW and urban costs that may be indicative of where substantial impacts are not likely:

- Average urban BMP costs plus average POTW costs (current residential sewer rate plus incremental annual costs per household) per urban household as a percent of MHI.

Estimated 2010 urban households reflect data from the 2000 Census and CBP population projections, as described in Section 5.2. Incremental POTW costs reflect costs to all the POTWs serving a county, divided by the total number of urban households. For urban households served by POTWs with no incremental costs under the tier scenarios (e.g., "insignificant" POTWs), total costs reflect current fees as estimated by the weighted average rate (weighted by the number of households served) for significant POTWs in the county. MHI is from the 2000 Census, adjusted to 2001 dollars using the CPI. Similar to the urban screening variable, this variable is not defined for counties that do not have an urban population.

Given the relatively greater data needs for evaluating potential for widespread impacts, there is no screening variable to identify areas that would not experience widespread impacts from costs in these sectors.

8.2 Screening Results

Exhibit 52 provides a summary of the screening variable values by tier scenario. The variable values are below 1% for more than half of the counties in the watershed in all three tiers. In Tier 1, over 90% of counties have screening variable values of less than 1%, and all counties have values of less than 2%. In Tier 2, almost 70% of counties have values of less than 1% and 94% have values of less than 2%, while in Tier 3, almost 55% of counties have a screening variable value of less than 1% and 83% have a value of less than 2%.

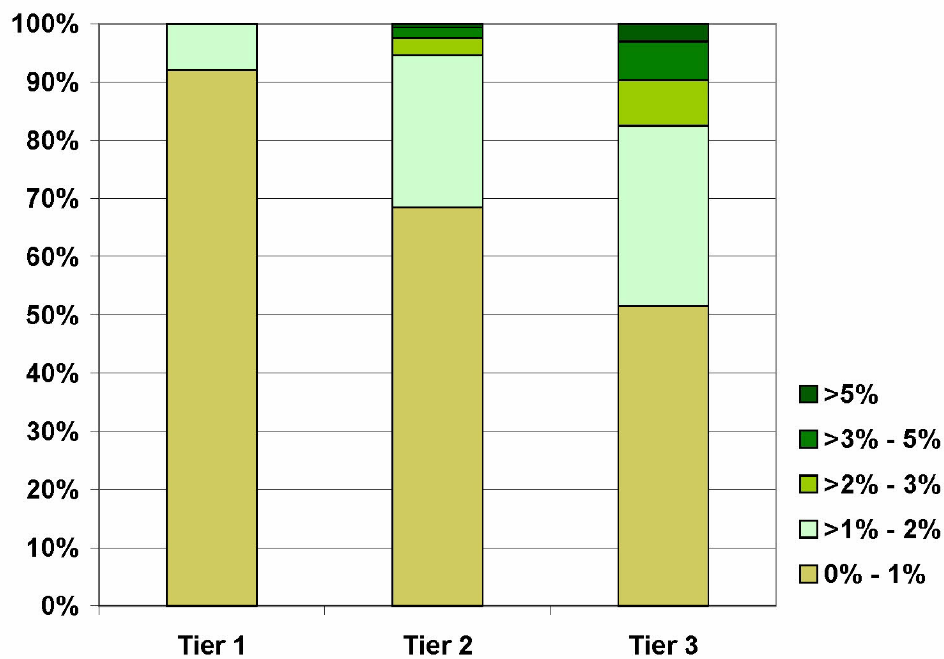


Exhibit 52: Distribution of POTW Plus Urban Cost Screening Variable Values

Exhibits 53 and **54** provide a geographic overview of the screening variable values for Tier 1 and Tier 3, respectively. Exhibit 53 shows that most of the counties with Tier 1 variable values in the >1% - 2% range are along the lower Rappahannock in Virginia, with a few on the eastern shore of Maryland and in Pennsylvania and western Virginia. Several of the inland counties with higher values in Tier 1 are counties with low urban populations relative the BMP costs. Exhibit 54 shows that most of the counties with high values in Tier 3 are in southern New York, northern and western Pennsylvania, and inland areas of Virginia and West Virginia. About two-thirds of the counties with variable values above 1% also have relatively small urban populations in the watershed. Counties that do not have urban populations appear white on the maps because the indicator is not applicable to those counties.

Because this screening variable includes information from both the urban sector and POTWs, sources of uncertainty that relate to those sectors also affect this variable. **Exhibit 55** provides a summary of those sources of uncertainty, which are discussed in greater detail in Sections 3.3 (POTWs) and 7.3 (Urban Sources).

8.3 Groundtruthing of Screening Results

To investigate how well the MPS-based screening variable for the urban combined sectors reflects actual MPS value, this section provides more comprehensive analysis of the results for Allegany County, MD. **Exhibit 56** provides a summary of the estimated costs and MPS screening variable across the tier scenarios. Costs for controls in urban areas range from $0.3 million under Tier 1 to $2.6 million under Tier 3, with the higher Tier 3 costs reflecting the more costly retrofitting of urban areas with storm water controls. The screening variable value incorporates an estimate of 19,386 urban households in Allegany County in 2010. When combined with POTW rate increases, household costs for BMPs on urban and mixed open land represent 0.8% to 1.2% of MHI.

EPA (1995) guidance indicates that a secondary test should be employed to further characterize the financial health of a community that has an MPS value over 1%. However, before drawing any conclusions regarding the potential for impacts of an MPS value of 1.2%, the accuracy of the POTW or urban BMP costs needs to be evaluated. Data from the 2000 Census indicate that the largest city in Allegany County (Cumberland, with a population of 21,518) has a density of 3.7 people per acre; the highest density is found in Lonaconing, with 4.5 people per acre, but only 1,205 people. (For comparison, the District of Columbia has 15 people per acre; Baltimore has 13). With lower population densities, urban retrofits may be less costly than the unit BMP costs (i.e., towards the lower end of case study cost ranges, instead of the mean values used in the screening analysis). In addition, federal or state cost-share funds have not been included as offsets to urban BMP costs. Thus, actual costs may be lower than indicated. If that is the case, then it is unlikely that urban households will experience substantial impacts from potential combined costs under any of the tier scenarios in Allegany county.

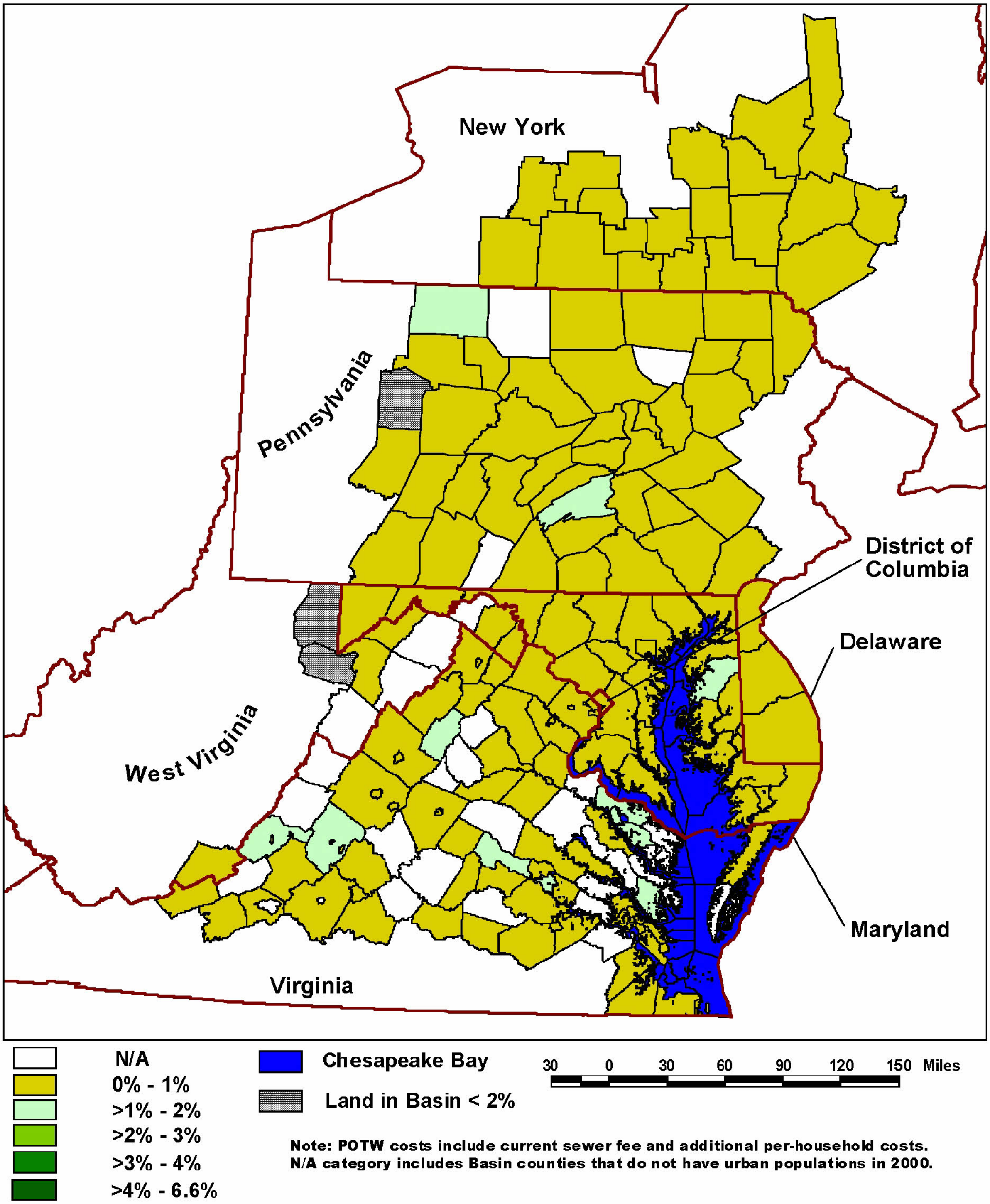


Exhibit 53: Comparison of Estimated Total Household Sewer Costs Plus Average Household Urban BMP Costs to MHI: Tier 1 (Combined POTW plus Urban BMP Screening Variable Values)

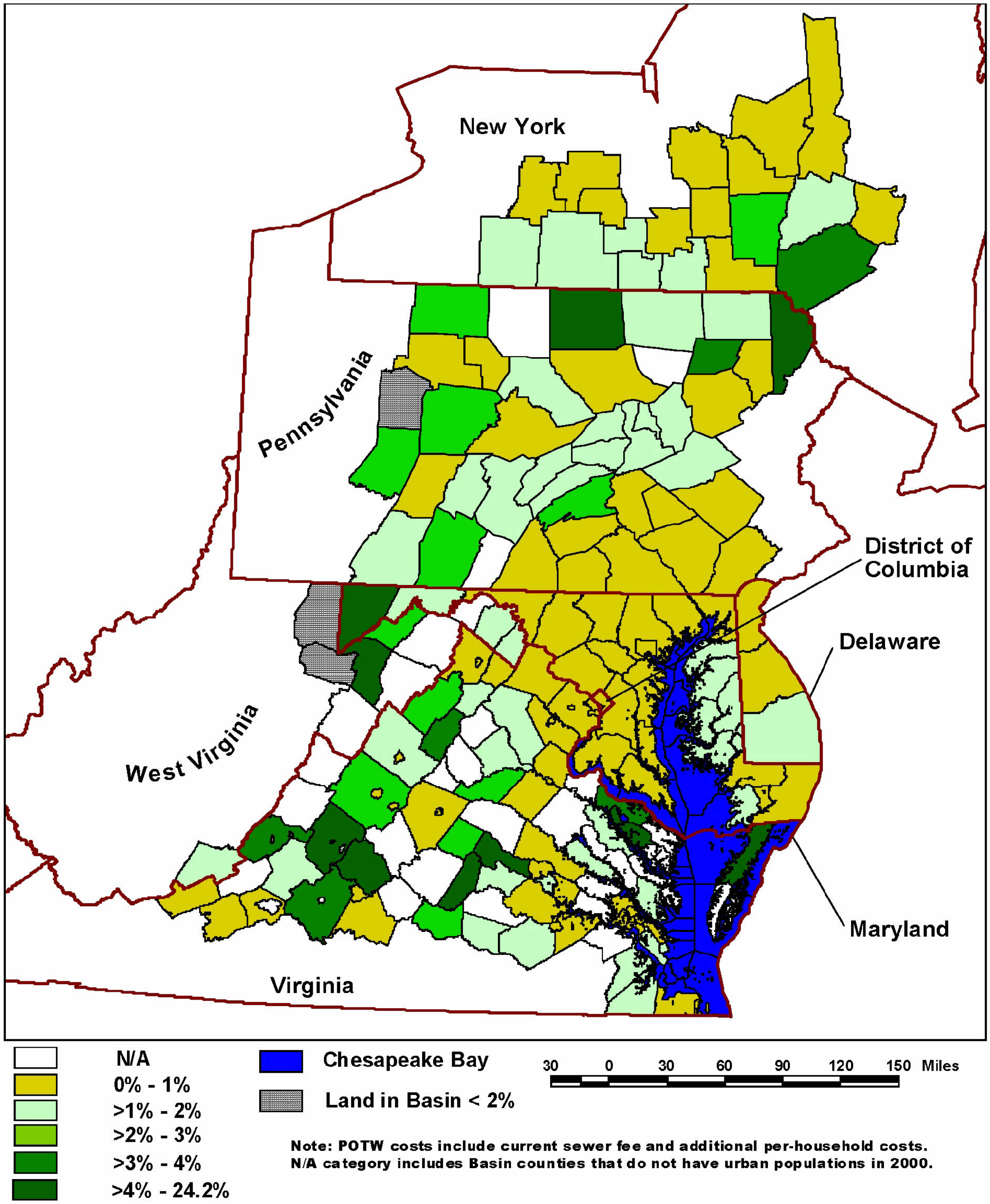


Exhibit 54: Comparison of Estimated Total Household Sewer Costs Plus Average Household Urban BMP Costs to MHI: Tier 3 (Combined POTW plus Urban BMP Screening Variable Values)

Exhibit 55: Sources of Uncertainty in the Total Urban Screening Variable

Source	Direction of Bias	Comments
Residential customers bear 100% of additional costs for most POTWs.	+	Actual MPS values will be lower after accounting for costs borne by industrial and commercial users.
No real income growth through 2010.	+	Actual MPS values will be lower in areas for which real person income is forecast to grow by 2010, and lower in areas where real income is forecast to decline by 2010.
Number of households served is calculated based on flow for 37 POTWs where other data are unavailable.	?	MPS screening values may or may not reflect actual MPS values.
Current annual residential sewer rate placeholder of $200 for 121 POTWs where other data are unavailable.	?	MPS screening values may or may not reflect actual MPS values.
Proportion of urban population in watershed equals proportion of total population in watershed.	?	Actual MPS values will be lower in areas where urban population is concentrated within the watershed, and higher in areas where urban population is concentrated outside the watershed.
Urban population growth equals overall county population growth.	?	Actual MPS values will be lower in urban areas that grow faster than the remainder of the county and actual MPS values will be higher in urban areas that grow less fast than the remainder of the county.
Urban MHI is assumed equal to overall MHI.	?	MPS screening values may or may not reflect actual MPS values.
Constant unit BMP costs applied to all BMP acres in the Basin.	?	Actual BMP costs will vary from site to site.

+ = assumption results in overestimating screening variable value
? = impact of assumption on screening variable values is unknown

Exhibit 56: Combined Urban Screening Data for Allegany County, MD (2001$)

Estimate	Tier 1	Tier 2	Tier 3
Urban & Mixed Open BMP Costs ($/yr)	334,503	854,364	2,572,116
POTW Costs Borne by Households (50% of capital costs plus O&M costs) ($/yr)	399,844	496,943	1,024,409
POTW Costs Borne by State (50% of capital costs) ($/yr)	242,874	252,145	533,205
Combined (POTW plus urban area control) Costs as Percent of County MHI	0.8%	0.9%	1.2%

9. SUMMARY

This section provides a summary of the sector-level screening analysis results. Consistent with the purpose of the screening analysis, the results indicate the jurisdictions (i.e., counties and independent cities) that are unlikely to incur substantial *and* widespread impacts, based on the values calculated for the screening variables. Note, however, that these variables are screening variables only, and more accurate data and actual tests of substantial and widespread impacts could produce different results.

Exhibit 57 provides a summary for Tier 1. Tier 1 generally represents baseline conditions that are expected to prevail regardless of any additional nutrient reduction programs or actions. Tier 1 may not, however, fully reflect baseline controls associated with the final CAFO rule, CZARA, and long-term CSO controls.[11]

As the summary shows, almost all jurisdictions incurring POTW or urban costs have substantial impact screening variable values less than 1%, and thus may be unlikely to incur substantial and widespread impacts. Similarly, the analysis of joint POTW and urban costs indicates that 92% of jurisdictions have screening variable values of less than 1%. Not included in this analysis are baseline household costs that may result from CSO controls, except the 43% reduction in CSOs in the District of Columbia. The timing and funding (e.g., cost share grants) for such programs are site-specific and not certain. Appendix E provides sensitivity analyses for three jurisdictions and additional information about CSOs in the Basin.

All jurisdictions have forestry sectors that represent a small share (less than 3%) of earnings. The small values indicate that the sector is small relative to the county economy and, therefore, a sector-level substantial impact (if any) is unlikely to have widespread ramifications.

Finally, 92% of jurisdictions have small agricultural substantial and widespread screening variable values (BMP costs represent less than 1% of MHI or agriculture represents less than 5% of earnings in the jurisdictions). This result reflects the earnings screening variable for farm income and related sectors. When only farm income is considered, 97% of jurisdictions are not likely to incur substantial and widespread impacts based on the low screening variable values.

Under Tier 2 (**Exhibit 58**), the urban sector is the least affected, with 95% of jurisdictions not likely to incur substantial and widespread impacts since BMP costs represent a small share of household income (e.g., less than 1%). POTW control costs in 85% of jurisdictions result in screening variable values of less than 1%. Finally, combined POTW and urban costs are below 1% in 69% of jurisdictions. Most of the remaining jurisdictions have substantial screening variable values in the 1% to 2% range and, therefore, may also have low potential for substantial and widespread impacts. An analysis of substantial and widespread impacts could be performed to verify this result.

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[11] Aside from controls specified in Tier 1 for the District of Columbia, the tier scenarios do not include controls on CSOs and SSOs because these sources are regulated separately, and costs are associated with protection of human health parameters such as fecal coliforms reduction. However, the Chesapeake Bay Program recognizes that the areas in the Bay watershed required to implement CSO and SSO measures will bear this additional cost burden, and thus the appendices include additional information on potential CSO and SSO costs.

Exhibit 57: Summary of Screening Analysis Results for Tier 1

Sector	Screening Analysis Results
POTW	96% of jurisdictions have POTW screening variable values < 1%
Urban	99% of jurisdictions have urban screening variable values < 1%
Urban Combined	92% of jurisdictions have combined POTW/urban screening variable values < 1%
Industrial	n/a
Agriculture[1]	92% of jurisdictions have MHI screening variable values < 1% or agricultural and related earnings < 5%
Forestry	100% of jurisdictions have earnings from forestry of < 3%
Onsite Waste Management	n/a

n/a = screening analysis not applicable for this scenario

1. The estimate increases to 97% if the earnings variable based solely on farm earnings is used.

Exhibit 58: Summary of Screening Analysis Results for Tier 2

Sector	Screening Analysis Results
POTW	85% of jurisdictions have POTW screening variable values < 1%
Urban	95% of jurisdictions have urban screening variable values < 1%
Urban Combined	69% of jurisdictions have combined POTW/urban screening variable values < 1%
Industrial[1]	95% of jurisdictions have industrial screening variable values < 5%
Agriculture[2]	89% of jurisdictions have MHI screening variable values < 1% or agricultural and related earnings < 5%
Forestry	100% of jurisdictions have earnings from forestry of < 3%
Onsite Waste Management	n/a

n/a = screening analysis not applicable for this scenario

1. Excludes 8 counties with missing earnings data for one or more sectors that include a substantial discharger.
2. The estimate increases to 97% if the earnings variable based solely on farm earnings is used.

The forest sector analysis is unchanged because the screening variable does not depend on tier scenario costs. The agricultural sector analysis shows that 89% of jurisdictions have MHI screening variable values of less than 1% or agricultural and related earnings screening variable values of less than 5%. This result is based on the more conservative earnings variable, which includes agricultural services and manufacturing industrial categories. The percentage increases to 97% if the earnings variable is based solely on farm earnings.

The Tier 2 screening analysis for industrial point sources shows that in most of jurisdictions having complete data, earnings from sectors with potentially affected dischargers (i.e., dischargers that have positive costs in Tier 2) represent less than 5% of all earnings. In fact, 95% of all jurisdictions have earnings variable values less than 1%. The screening variable for eight jurisdictions cannot be evaluated because of missing BEA data. An analysis of substantial and widespread impacts could provide information for these jurisdictions as well as for those with the larger shares of earnings from the sector (e.g., > 5%).

Under the Tier 3 scenario (**Exhibit 59**), 81% of jurisdictions have POTW screening variable values of less than 1%, 79% have urban screening variable values of less than 1%, and 52% have screening variable values of less than 1% for combined urban and POTW costs.

Exhibit 59: Summary of Screening Analysis Results for Tier 3

Sector	Screening Analysis Results
POTW	81% of jurisdictions have POTW screening variable values < 1%
Urban	79% of jurisdictions have urban screening variable values < 1%
Urban/POTW Combined	52% of jurisdictions have combined urban/POTW screening variable values < 1%
Industrial[1]	94% of jurisdictions have industrial screening variable values < 5%
Agriculture[2]	88% of jurisdictions have MHI screening variable values < 1% or agricultural and related earnings < 5%
Forestry	No jurisdictions have earnings from forestry of >3%
Onsite Waste Management	Only 1% of existing systems (fewer than 1% of total households) affected

1. Excludes 8 counties with missing earnings data for one or more sectors that include a substantial discharger.
2. The estimate increases to 97% if the earnings variable based solely on farm earnings is used.

Tier 3 results for agriculture in Exhibit 59 are nearly identical to Tier 2 results despite BMP cost increases. This similarity happens because the earnings variable is constant across the tier scenarios, and it becomes the binding constraint on the meeting both conditions.

One additional sector incurs costs under Tier 3—the household onsite waste management BMP. The screening analysis indicates that onsite waste management BMPs affect fewer than 1% of total households (less than 1% of existing onsite systems), such that any substantial financial impacts are not likely to have a widespread impact on the community.

Groundtruthing of the screening variable values for Allegany County, Maryland provides insights into the validity of the screening analysis variables. For example, better POTW sewer rate and residential service data generate slightly lower MPS values, which do not contradict the outcome of the screening analysis. This confirms that the conservative design of the screening analysis prevents false conclusions of a county having little or no potential meet EPA impact criteria.

The comprehensive analysis of the agricultural sector indicates that the agricultural variables most likely overstate the potential for impacts. In particular, the livestock cost screening variable generates uncertain results that, on closer inspection, are not indicative of a high likelihood for impacts. Instead, the results indicate that the conservative design of the screening analysis has a tendency to generate uncertain results in instances where substantial impacts may not be seen. The BMP costs in the livestock screening variable may not reflect cost-effective control measures given the level of intensity of animal agriculture in the county and, thus, the result may reflect an upward bias in the BMP costs rather than a potential for impact.

The macro economic model results shown in Part II provide an important perspective that is missing from the screening analysis—that one sector's cost is another sector's revenue. Thus, the net economic impact of a tier scenario depends ultimately on complex industrial and market relationships that cannot be evaluated without a macro economic model. Results from model simulation for Maryland demonstrate that the net economic impact is positive. In particular, model results indicate a net increase in overall economic output and employment because costs in each sector are offset by revenues they generate in other sectors. This happens because the expenditures occur in sectors with higher regional output and employment multipliers, and some of the expenditures represent an influx of federal funds to the region. These two factors – coupled with the effect that annual compliance costs are small compared to the regional economy – negate any potential for adverse widespread impacts at the watershed level. It is possible that the same factors will limit potential for widespread impacts at other levels of aggregation as well. These regional modeling results do not include the market benefits (e.g., to commercial and recreational fishing industries) in coastal counties, that may result from improved water quality.

10. References

Allegany County Department of Economic Development. 2002. Fast Facts: Brief Economic Facts. Online at http://www.alleganyworks.org/fast_facts.htm.

Bureau of Economic Analysis (BEA). 2001. Regional Economic Information System, 1969-1999. Department of Commerce, Economics and Statistics Administration.

Bureau of Labor Statistics (BLS). 2002. Consumer Price Index - All Urban Consumers (CPI-U). U.S. City Average, All Items, 1982-1984=100. Online at http://www.bls.gov.

Harford County Benchmark Study. 2000. Questions for Bench Marking: Allegany County. Online at http://www.co.ha.md.us/dpw/ws/benchmark/.

Jones, Edgar (Fairfax County, VA). 2003. Personal email communication to Bob Ehrhart, VA DEQ, June 30, 2003.

Metropolitan Washington Council of Governments (MWCOG). 2002. Cost Allocation Methodology for the Blue Plains Wastewater Treatment Plant. COG staff document approved by BPTC, April 14, 2002.

Personal communication with Allegany County Utilities Division. 2002.

Personal communication with Cumberland Wastewater Treatment Plant. 2002.

Personal communication with J. Gambaccine. 2002. Northern Neck Planning District Commission.

Personal communication with R. Snyder and K. Hanft. 2002. Allegany Public Works Department.

U.S. Census Bureau. 2002. 2000 Decennial Census of Population and Housing. Department of Commerce, Economics, and Statistics Administration.

U.S. Census Bureau. 2000. 1997 Economic Census. Department of Commerce, Economics and Statistics Administration. Online at http://www.census.gov/epcd/www/econ97.html.

U.S. Census Bureau. 1993. Geographic Areas Reference Manual. Department of Commerce, Economics and Statistics Administration. Online at http://www.census.gov/geo/www/garm.html.

U.S. Department of Agriculture (USDA). 2002. Income, Wealth, and the Economic Well-Being of Farm Households. Ashok K. Mishra, Hisham S. El-Osta, Mitchell J. Morehart, James D. Johnson, and Jeffery W. Hopkins, Farm Sector Performance and Well-Being Branch, Resource Economic Division, Economic Research Service. Agricultural Economic Report No. 812.

U.S. Department of Agriculture (USDA). 2001. Table 2. Normalized Market-Clearing Price Estimates, National-Level Indices. Memorandum from S. Offutt to M. Gray, subject 2001 Normalized Prices.

U.S. Department of Agriculture (USDA). 2000a. 1997 Census of Agriculture. National Agricultural Statistics Service.

U.S. Department of Agriculture (USDA). 2000b. Agriculture Fact Book 2000. Office of Communications. Online at http://www.usda.gov/new/pubs/fbook00/contents.htm.

U.S. EPA. 2001. Weighted Average Interest Rate for Clean Water SRF Assistance, by State. Office of Wastewater Management and Region 5 Water Division. Online at http://www.epa.gov/r5water/cwsrf/pdf/ratest.pdf.

U.S. Environmental Protection Agency (U.S. EPA). 2000. Guidelines for Preparing Economic Analyses. EPA-240-R-00-003. Washington, D.C.: U.S. Environmental Protection Agency, Office of the Administrator.

U.S. EPA. 1998. 1996 EPA Office of Water Clean Water Needs Survey (CWNS) for the United States and U.S. Territories. Report 2: Population Served and Flows for Publicly Owned Wastewater Treatment Facilities Currently in Operation.

U.S. EPA. 1995. Interim Economic Guidance for Water Quality Standards, Workbook. Office of Water.

Viessman and Hammer. 1998. Water Supply and Pollution Control. Addison Wesley: Menlo Park.